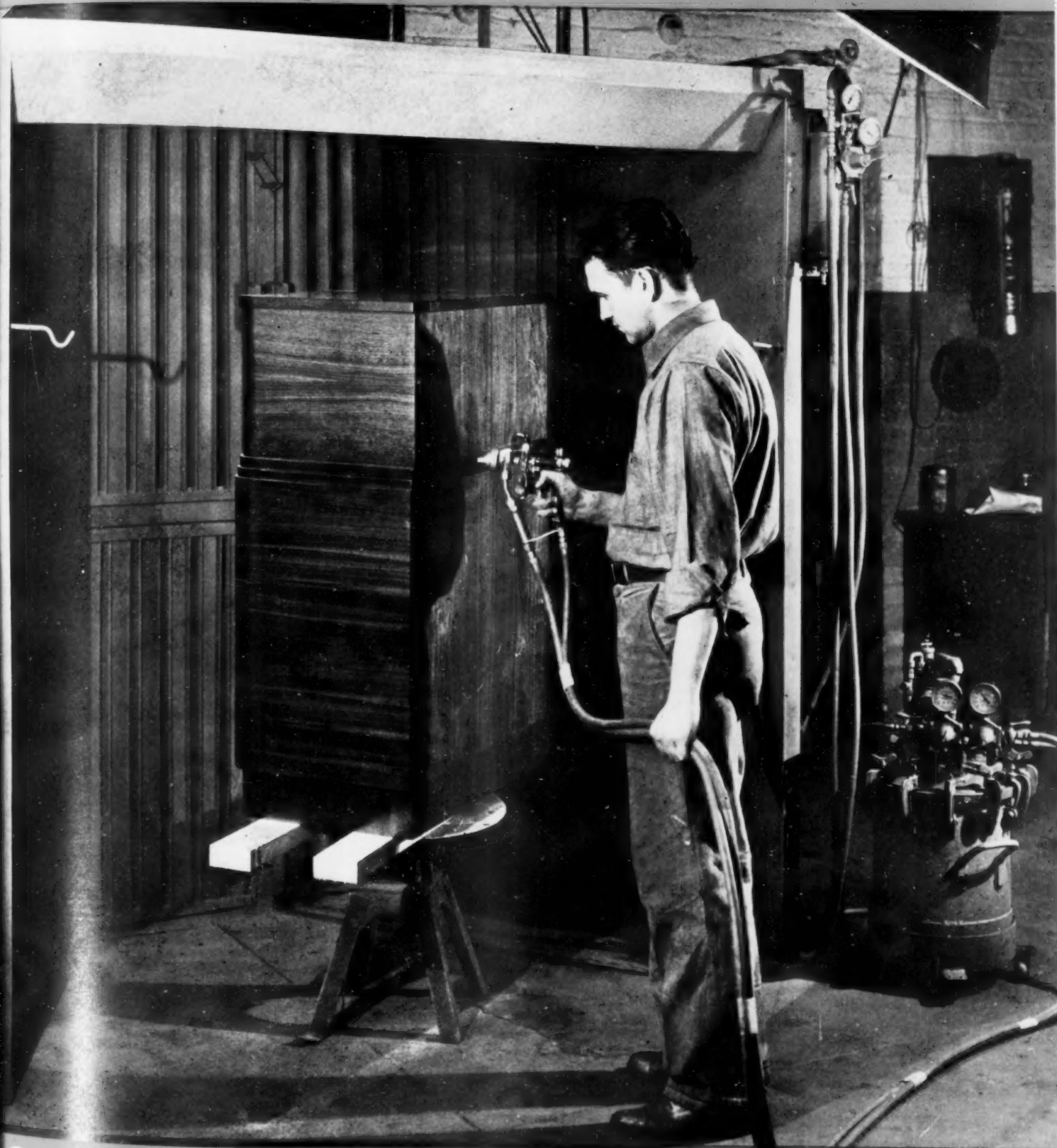


APRIL, 1941

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# ORGANIC FINISHING

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APRIL, 1941

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## Finish Failures by Weathering

Recent investigations have shown that there are four principal natural causes which produce finish failures in outdoor applications and, to a somewhat lesser degree but of the same general nature, in indoor applications. Most important of these is sunlight, which may act in one or both of two ways. Sunlight may produce a direct destructive change on some or all of the constituents of the finish film or it may act indirectly as a catalyst in speeding the action of moisture, gases, volatile substances, etc. of the air which come in contact with the finish film.

Oxygen of the air is another factor of consequence in the breakdown of finish films exposed to weathering. Many of the constituents of finishing materials, particularly those which are organic in character such as the gums, resins and oils are not inert to oxygen and change by oxidation so that their original function in the film is impaired.

The third effect is that of water, either as rain or as water vapor, which may have an erosive or solvent action on the film.

Finally, there is expansion and contraction of the film resulting from changes in temperature. Such expansion and contraction may cause the film to break apart or even loosen the film from the surface which it was designed to protect or decorate.

It is apparent that weathering is not a single, simple action. It is quite complicated, mainly because the four factors which were pointed out above are variable from one part of the country to another. They are variable not only as to degree, but also as to the order in which they may occur and the combinations in which they may occur. Therefore, the selection of a finishing material for applications subjected to weathering must be very carefully made. The best basis of selection is, of course, a log of experience with finishes actually exposed to weather in various sections. The next best is a complete knowledge of the weather conditions in that part of the country where the finish is to be exposed plus accelerated tests intelligently run and interpreted.



# The Measurement of Gloss\*

L. A. WETLAUFER and W. E. SCOTT

E. I. du Pont de Nemours & Co., Philadelphia, Penn.

**G**LOSS is a major component of the general appearance of an organic coating and often has direct bearing upon the serviceability of the film. Since visual observation of this property does not provide an adequate means of recording exact reflection characteristics and, therefore, furnishes but a meager basis for comparing gloss observations which are made at different periods, and since product standards, both wet and dry, may drift toward either higher or lower gloss on aging, an accurate method of measurement is important.

No method for the measurement of this property appears to be in general use. It is believed that insufficient attention to two important factors is largely responsible for the lack of instrumental application. First, and highly important, is the matter of eliminating extraneous factors, such as macroscopic texture, permitting thereby a measurement of gloss *per se*. It must be recognized that any factors affecting appearance which are not inherent in the paint itself as manufactured and before it is laid down as a paint film—for example, factors which are introduced by the method of application—must be eliminated or controlled if one wishes to ensure the uniformity of the product by physical testing. Secondly, instruments which

have been offered commercially have, in the opinion of the authors, not provided the necessary flexibility to enable satisfactory measuring of both high and low gloss or have been lacking in the precision required for adequate correlation with visual observations.

Since the ultimate goal of the work herein described was to provide a simple and yet sufficiently accurate method for writing correct specifications and finally to establish a method which could be applied practically to the manufacturing operation, it seemed obvious that the conditions necessary for attainment of this goal could best be established through a fundamental study of the reflection characteristics of all types of surfaces common to the coating industry.

The measurement of the spatial distribution of light reflected from a surface under given illumination is known as goniophotometry. In practice, the reflection distribution is determined for a given angle of illumination in a plane normal to the surface. From such data it is then possible to select the angles of illumination and viewing, or possibly the one angle sufficient for the control of a given product, no matter where it falls in the gloss range.

Having thus explored the gloss range and having provided means for preparing films free from extraneous in-

fluences, it should be possible to indicate a suitable method for routine control.

Several investigators, notably Jones<sup>6</sup>, Judd and Hunter<sup>4,5</sup>, and Hanstock<sup>3</sup>, have made goniophotometric investigations of various surfaces, but there is no suitable instrument commercially available nor has there been published what appears to be a sound basis for the development of a satisfactory method for routine control work.

This paper describes the work leading up to the final stage—namely, that of designing as simple an instrument as possible commensurate with the indicated requirements in precision.

## Definitions and Method

The following fundamental terms used in the discussion are defined following Jones<sup>6</sup>, and Hunter and Judd<sup>5</sup>:

Gloss is the property of a surface by which it reflects light specularly.

Glossiness of a surface is the appearance ascribable to its gloss.

Apparent reflectance of a sample is the reflectance which a perfectly diffusing surface would require in order to yield the same brightness as the sample under the same conditions of illumination and viewing.

It is necessary in studying the reflective properties of a material to measure apparent reflectance as a function of angles of incidence and view.

\*Reprinted from "Industrial and Engineering Chemistry, Analytical Edition," 12, 647 (1940)

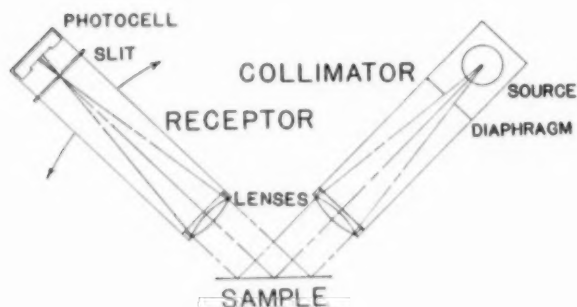


Figure 1. Schematic Diagram of Optical System of a Goniophotometer.

Collimator is fixed; receptor and sample may be rotated about the center of the surface of the sample, either separately or together.

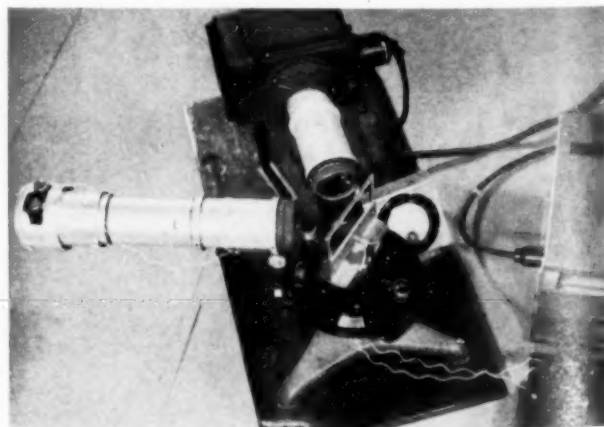


Figure 2. Goniophotometer.



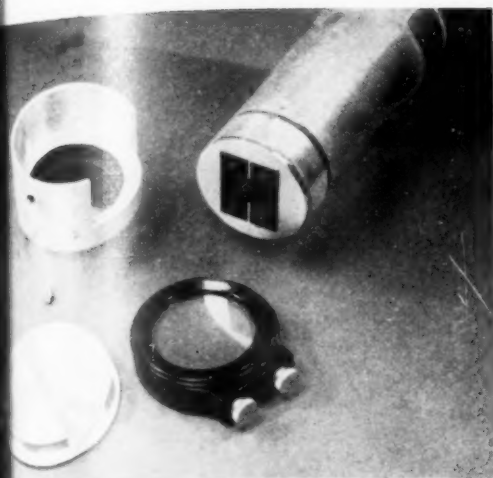


Figure 3. Detail of Split and Photocell Mounting.

As a result of various factors<sup>4,7</sup>, light reflected from a surface has undergone a change in spatial distribution and intensity. The spatial distribution of reflected light is directly related to the gloss of the surface, but no means of getting a numerical value for gloss from the distribution as a whole has been established. For unidirectional illumination, specular reflection is reflection taking place at the first contact of the incident light with the reflecting medium. Diffuse reflection, which takes place within the medium, is directly related to the brightness of the surface. Specular reflection in the case of an optically smooth surface is confined to the direction of mirror reflection and is dependent only on the angle of incident illumination and the refractive index of the reflecting material. While a specified unidirectional illumination and a given refractive index, it is possible to obtain a measure of the smoothness of the surface.

Departures from optical smoothness are being considered as microscopic in character. This method of measuring smoothness provides a means of controlling the inherent gloss of the paint or enamel itself. It implies carefully controlled preparation of surfaces for measurement. The effect of refractive index is important only when one is comparing high-gloss products whose composition is different. For control work on a given product it is not a factor. The extent of variation of specular reflection with refractive index may be determined for a given angle of incident illumination from Fresnel's equation<sup>2</sup>.

From this point of view there is only one type of gloss, which will be

referred to as inherent gloss. This term is used to indicate the gloss, as defined above, of a surface free from macroscopic texture or irregularities. The fact that the angle or angles of viewing and illumination must be changed in order to get a better measure of the relative degree of smoothness among different classes of finishes, such as high gloss and low gloss, does not mean that we must give a new name to each of the quantities measured under the various conditions. When it becomes possible to measure separately the effect of extraneous factors, such as spray wave, orange peel, brush marks (macroscopic texture in general), and haze, and to relate them with a measure of inherent gloss to obtain a numerical value correlating with visual judgments of appearance, the result will be valuable. However, from the control viewpoint the method presented here will not be altered.

The features which it is believed should be incorporated in the design of a goniophotometer which would enable one to measure the distribution of reflected light from surfaces are as follows:

The instrument should have sufficient angular resolving power to give the greatest possible separation of specular and diffuse reflection. The practical limitation in this respect is getting enough light through the system to be measurable. The angular resolving power could be increased beyond that of the instrument to be described, but only by using a more intense light source and a more sensitive light-measuring device. The conditions finally selected are those which give sufficient resolving power to permit good correlation with visual observations.

Assuming the instrument to be of the photoelectric type, the photocell response to color, for a given source of illumination, should be as close as possible to that of the average human eye and its response should be linear over the range of intensities encountered.

It should be adjustable for all angles of unidirectional illumination and viewing in a plane normal to the reflecting surface.

It should have sufficient sensitivity and range to enable one to measure all the light intensities which would be encountered, without the use of neutral filters, wedges, and similar devices which are difficult to reproduce or calibrate.

The optical system should be easily reproduced.

A schematic diagram of the optical system of a typical goniophotometer employing collimating lenses is shown in Figure 1. Figures 2 and 3 show the actual apparatus.

The base of the instrument is a Gaertner student spectrometer having a graduated circle and vernier which enable measurements of the desired angles to be made to one minute of arc. The panel holder replaces the spectrometer table, so that the face of the panel coincides with the axis of rotation of the arm carrying the receptor. The collimator is fixed, and receptor and sample holder may be rotated about an axis passing through the front face of the sample. The light source, placed at the focus of the collimating lens, is a 6-volt, 108-watt ribbon filament lamp having a prefocus base. A diaphragm is placed between the source and collimating lens to cut out stray light from the lamp housing and sides of the tube. The lenses of both collimator and receptor are achromatic lenses having a focal length of 20 cm. and a diameter of 5 cm. A practically parallel beam of light is then incident on the sample, say, at 45°, and reflected in a manner to be determined.

The receptor, by means of which practically parallel reflected rays in any desired direction may be selected, is composed of lens, slit, and photocell. The slit is placed at the focus of the receptor with its long axis perpendicular to the direction of rotation of the receptor. The photocell placed behind the slit is a Westinghouse barrier layer type, trade name "Photox". The galvanometer used to measure the photocell current is a Rubicon Spotlight galvanometer having a sensitivity of approximately 0.008 micro-ampere per millimeter and a resistance of 340 ohms. To vary the range an Ayrton shunt of 10,000 ohms' total resistance is connected across the galvanometer. The shunt is marked with the multipliers 1, 5, 20, 50, and 100 to be applied to the scale readings of the galvanometer.

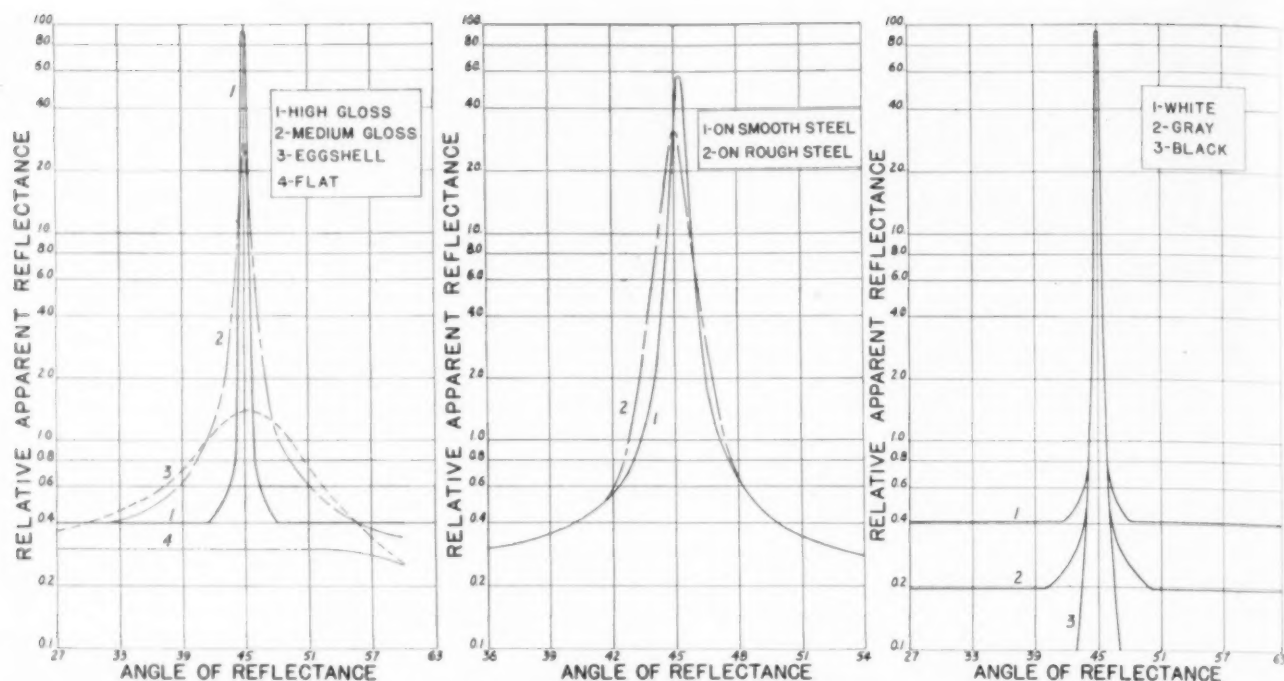
An instrument as sensitive as this is subject to fluctuations of line voltage on the lamp. To prevent these fluctuations from affecting the lamp, a rheostat is connected in series with the lamp on a 115-volt direct current line to drop the voltage to 6 volts and a heavy-duty 6-volt storage battery is "floated" across the lamp to take up the momentary fluctuations in line voltage. A voltmeter is also connected across the lamp. A null method using two photocells in a bridge circuit is also commonly used in photometric measurements. There are several of these circuits in which readings are independent of lamp fluctuations.

The specifications for the instrument are as follows:

Aperture sums<sup>5</sup>: 50' × 5.5".

The source-receptor combination<sup>1,5</sup> is an incandescence source operating at a color temperature between 2800° and 3000° K and a Photox barrier layer photocell.

The reflectance standard used is a highly polished piece of black glass which has arbitrarily been assigned a relative apparent reflectance value of 100 for specular reflection at any angle. Actually when illuminated and viewed at 45° under the above conditions as compared to a magnesium oxide<sup>8</sup> surface, illuminated at 45° and viewed normally, its apparent reflectance is 200.



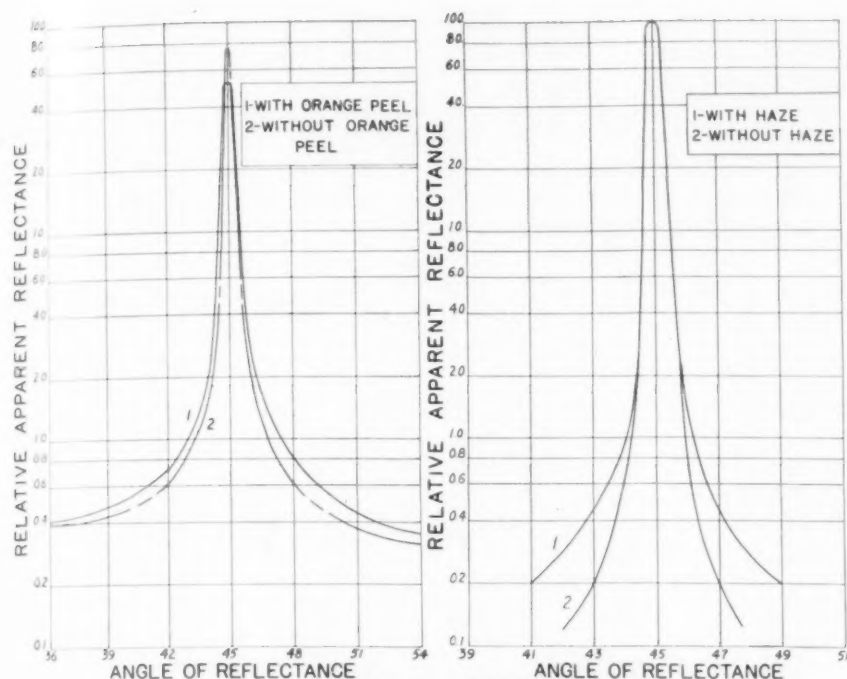


Figure 5. Distribution of Reflected Light.

Illumination —45°, aperture sum 50'

Left. Effect of macroscopic texture. White finish on plate glass.

(1) sprayed, (2) applied with doctor knife

Right. Effect of haze

give proper emphasis to the various measurements.

Figure 4 (left) shows four goniophotometric curves obtained from measurements on representative finishes of the four common gloss classes—high, medium or semigloss, eggshell and flat. The color of all these finishes is white. The curves show how the reflected light is scattered over a wider angle around the direction of mirror reflection (45°) as the gloss of the surfaces decreases. The fact that the whites are not all of the same brightness is indicated by the position of the horizontal parts of the curves to the left of the peaks.

In Figure 4 (center) is shown the effect of the panel material on the distribution of reflected light. The product, a high-gloss white, was applied by means of the doctor knife to two types of 24-gage steel panels, 10 × 30.5 cm. (4 × 12 inches) commonly used in finishing work. One panel had a more porous surface than the other, the result being a poorer appearance when covered with a finishing material. The effect is even more pronounced if a wood panel is used. Another effect which panels such as steel, wood, tin, and pressboard have on goniophotometric curves is distortion of the spatial distribution of reflected light, due to the fact that the panels are not flat. Any departure

from flatness of the panel will also have a serious effect on the film thickness, if one attempts to apply a film by means of the doctor knife. The effect of the rough surface is shown by the lower peak and increased width of curve, indicating more light reflected in directions adjacent to 45°. The peak of the curve corresponding to the finish over the smooth steel is displaced 15 minutes from 45°. This shows the effect of slight curvature of the panel material.

In Figure 4 (right) the effect of the brightness of the paint on the distribution curve is shown. The curves represent, in order of decreasing brightness, three high-gloss finishes, white, gray, and black, respectively. The effect is the same with chromatic colors. The diffusely reflected light represented by the horizontal part of each curve decreases; the remainder of the curve is not affected if the smoothness of the surface and the refractive index remain the same.

Fig. 5 (left) shows the effect of macroscopic texture introduced by spray application. The texture is a combination of spray wave and orange peel. Macroscopic texture, as this, or brush marks, makes visual observations difficult and instrumental measurements of inherent gloss impossible. Experienced observers generally claim to be able to disregard such effects in mak-

ing visual judgments and many do well, but they are not consistent. Figure 5 (left) shows that the peak of the curve is lowered and the width increased, when this form of texture is present; in other words, from the graph it might be wrongly inferred that this finish had lower inherent gloss.

In Figure 5 (right), the effect of surface haze on the distribution curve is shown. This is a factor in appearance which, if present, cannot be eliminated by the method of application outlined above. The peaks of the curves are the same, the only change being a slight increase in apparent reflectance at angles adjacent to 45°. The fact that the peaks and the half-intensity breadths are the same indicates that the surfaces possess the same degree of smoothness.

The goniophotometer described may be used for measurements of the smoothness of plastics and metal surfaces and for measurements of hiding power, chalking, and holding-out of enamel top coats, and may be applied to the specification of diffusion materials, such as glass, the transmission distribution as well as the reflection distribution being measured.

#### Simplified Technique for Control

As obtaining goniophotometric curves on all batches of products manufactured is very time-consuming, some simpler method is desirable. Going back to the definition of gloss, that property of a surface by which it reflects light specularly, the spatial distribution of reflected light provides the best basis for the specification of gloss. However, if the method of preparation outlined above is used, the peak of the distribution curve—that is, the relative apparent reflectance in the direction of mirror reflection—is an index to the shape of the rest of the distribution curve. The evidence for this is the fact that all the comparisons which have been made of the gloss of finishes prepared in this manner have correlated with visual observations.

There remains the problem of selecting the proper angles and apertures to give the greatest selectivity throughout the entire gloss range. In Figure 6 is shown a plot of the relative apparent reflectances of a group of fourteen finishes for two angles and three apertures.

Flats are not included here because they do not represent as difficult a con-



trol problem as the higher gloss finishes. One limit for flats is the ideal perfectly diffusing surface. The top limit generally is such that all surfaces possessing gloss values between these limits are equivalent in practical use. Nos. 1 and 2 are in the high-gloss range; 3, 4, 5, 6 and 7 are semigloss or medium; 8, 9, 10, 11, 12, 13 and 14 are eggshell. The numbers indicate the order in which four experienced observers rated the panels visually. A number of significant conclusions may be drawn from these data.

1. At 45° and an aperture of 50' good separation of the finishes in the high and semigloss range is obtained and the order corresponds to that obtained visually.

At an aperture of 2.5° the separation is fair, and the order is correct. This is not true under any of the other conditions of measurement.

2. At 45° and apertures of 50', 2.5°, and 5.0° considering the eggshell samples, the order of Nos. 11 and 12 is the reverse of the visual order. Also at apertures of 50' and 2.5° the relative apparent reflections of the eggshells are very low.

3. At 60° and all apertures, good separation is obtained for eggshells and the order corresponds to that obtained visually.

4. At 60° and all apertures the high and semigloss finishes are out of order and especially at 2.5° and 5.0° the separation is poor.

All flats fall below sample 14, no matter what the conditions of measurements. High-gloss finishes seldom change order with a change in angle of illumination, but low eggshells, such as Nos. 11 and 12, often do. Since this work was done over a year ago, the angle at which measurements of eggshells and flats were made has been increased to 67.5°, because greater separation of these finishes is obtained without altering their order, especially low eggshells and flats. These angles, for high-gloss and low-gloss measurements, can of course be varied within reasonable limits without affecting the order of the results. It is not necessary to increase the angle beyond 67.5° in order to measure adequately the differences in a group of the lowest gloss finishes.

Therefore, the conditions of measurement recommended for control work would be:

For high and semigloss finishes, an angle of 45° and aperture sum not exceeding 2.5°.

For eggshells and flats, an angle of 67.5° and an aperture sum not exceeding 2.5°.

These conclusions appear reasonable because, in practice high and semigloss finishes are observed either nor-

mally or at about 45° or both, while eggshells and flats are observed at greater angles.

An instrument embodying all the features considered above, and with which the necessary measurements for the control of gloss can be made, has been designed. The design embodies greater simplicity, ruggedness, and compactness with no decrease in sensitivity as compared to the goniophotometer described herein. For example, while the instrument is still a goniophotometer in that it is possible to vary the angles of incidence and viewing from 0° to 70°, it is enclosed, with the exception of the galvanometer, in a metal box which is provided with an opening over which the sample is placed. Thus dirt collection is prevented and the moving parts are protected from accidental blows. The collimator and receptor tubes have also been removed in the interest of decreased cost of construction. They are not necessary in a properly shielded, light-tight box. All adjustments of angles of viewing and illumination are made from the outside. The instrument will employ faster lenses, but will illuminate a slightly smaller area of the sample, in order to obtain an angle of 70° for illumination and viewing inside of the box. The cross-sectional area of the illuminating beam is approximately 12 sq. cm. A null method by which the readings will be obtained directly in terms of the secondary standard, independent of intensity fluctuations of the light source, will be employed.

### Summary

Previous investigators have attempted to correlate so-called "gloss" measurements of surfaces with visual observations of the surfaces. Inherent gloss, however, is only one factor in the appearance of a surface and in order to measure it, it is necessary to prepare paint films such that the inherent gloss is the only factor in the measurement. A refined method of preparing paint surfaces for measurement—namely, doctor-blading on plate glass—is introduced to control or eliminate extraneous factors affecting goniophotometric measurements and visual observations of inherent gloss. The construction of a goniophotometer for research work on gloss in the finishes field and other fields is described and complete specifications are given. Finally, for control work in the case of

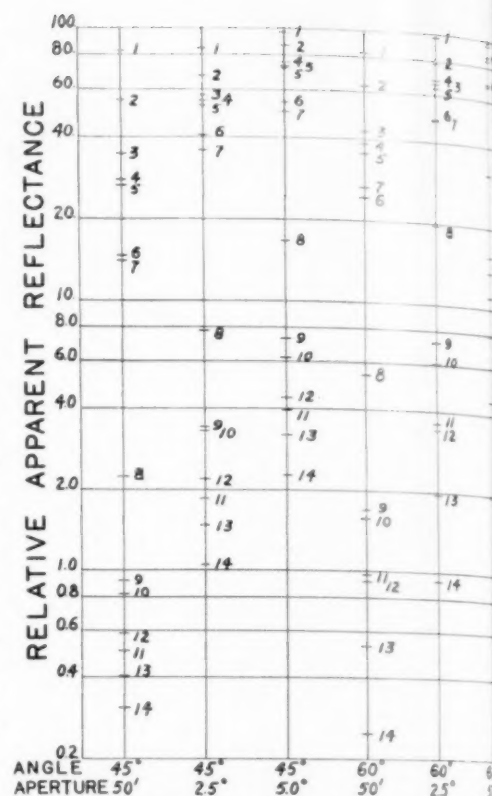


Figure 6. Variation of Relative Apparent Reflectance in the Direction of Mirror Reflection with Angle of Illumination and Aperture Sum.

Polished black glass = 100

high and semigloss finishes, the relative apparent reflectance in the direction of mirror reflection for unidirectional illumination at 45° should be measured, the aperture sum not to exceed 2.5°. For eggshell and flat finishes, the relative apparent reflectance in the direction of mirror reflection for unidirectional illumination at 67.5° should be measured, the aperture sum not to exceed 2.5°.

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—Presented before the Division of Paint and Varnish Chemistry at the 99th Meeting of the American Chemical Society, Cincinnati, Ohio.

# Training of Spray Operators

By W. P. BALDWIN

New York

## Introduction

Today it is a recognized fact that organic finishing is changing from the old hit-and-miss trial methods into a scientific, pre-determined and well ordered system of finishing procedure. The advancements in chemistry and other sciences have brought into use organic finishes of higher quality than those of yesterday and advanced equipment has given us a higher finishing production with lower costs.

A finishing system is, by its very nature, a complex order of things, and is made up of several factors, whose success depends not upon one factor, but upon all factors. Now, in spite of all the advancements in organic finishing, very little attention is really given to the technique used by the spray men and others of the finishing room personnel, for an analysis shows that the system used in training a spray operator is today still the old hit-and-miss way of doing things of yesterday.

In a previous article<sup>1</sup> on spray motion technique, the writer discussed the two fundamental principles, which are necessary to train and develop a spray operator of high ability. These are, first, the selection of a spray operator on a physical capability basis; and second, the training of an operator in the technique of a "spraying rhythm." This article will deal with the values to be saved in dollars by giving the spray operator or trainee a pre-education or spray training system in spraying technique, or a practical and educational training in fundamental organic finishing.

However, at this point we must inquire as to really what is a spray operator, for many claim to be such but as experienced foremen know, few really are.

## Qualifications of a Sprayer

From a rating point of view, a top-

notch spray finisher is one who would have an evaluation of approximately sixty per cent efficiency which is the highest known efficiency to date. In simple words, the question is, "can you produce?" Can you meet the demands of production and more, if necessary?

The earmarks of a topnotch spray operator are: that he is a high speed worker and is able to step into the breech under any conditions on any job, and meet the production demands without the usual playing around—ands, ifs and buts. He is capable of maintaining his equipment, is fully experienced and what is more important, well educated in the technique of handling various types of finishes.

In addition to having the two fundamental principles of experience and education, there is another outstanding and interesting fact about this class of sprayers and that is that they have had the opportunity of owning their equipment with which to experiment with the ins and outs of using a spray gun. This is, naturally, a tremendous advantage over a man who has had no such opportunity, and this



W. P. Baldwin

fact is an important phase of their high efficiency.

Naturally and logically the thing to do is to adopt their system, ways and means, if we are to raise the efficiency of others with low efficiency into the ranks of topnotch finishers. We cannot give a man any more experience than he has had, but we can give him a potential training experience, or a concentrated actual experience if we use the means to do so. We can also give a man a practical all-around finishing education, by simply adopting a well ordered training system and in doing so, lower our production costs and increase our production rate.

Now, having used the word "rating," it would be well to give an explanation as to its meaning. Rating is an evaluation in percentage of a man's ability or his overall productivity, based both on labor utilization and material consumption.

## Eliminate Weak Spots

In every progressive finishing department an "Evaluation of Spray Operator Ability" should be determined so as to know just where the weak spot in a finishing department is. It may be either labor or material.

Now, having determined the operator with a low factor, your objective is to start working at this point and proceed upward in a well ordered manner, cracking down on the weak spots step by step. For example, after having recorded the efficiency of your spray operators and having given each man a percentage rating in efficiency, the logical and well ordered thing to do would be to analyze the spray operator with the lowest rating and then proceed to build up his efficiency. If this operator were spraying 50 gallons of material per week and he were one of those operators who, on an average, waste one quart of paint out of every gallon consumed, and the loss were due to improper spraying tech-

nique, it would amount to (if the paint cost \$2.00 per gallon) a loss of \$25.00 per week, or \$100.00 per month, or \$1200.00 per year. Naturally, this amount of money would be quite a loss to the company and even if the operator's loss were one half a quart per gallon, or a \$600.00-loss per year, this is still quite a sum of money to lose. In addition, if it takes this same operator one hour to spray five quarts of paint, it means that two hours per day are devoted to spraying his loss of ten quarts per day, and at the labor rate of 75c per hour, it amounts to a loss of \$30.00 per month in wages paid and nothing to show for it. The total loss per year, both material and labor, amounts to \$1560.00—and still not counting solvent losses and handling of rejects.

### Method of Approach

The next question is how to remedy the situation thoroughly and in the shortest time possible. If there is good and bad technique in spraying, certainly the same truth holds for the training or correcting of an operator in the technique of handling a spray gun efficiently. Of course, one might hand a man his pay envelope but then if you employ a new operator, it is a pretty good wager that you will have the same initial problem all over again, plus all the liabilities and troubles that go with breaking in a new employee. So, really, there is no gain in discharging an operator if on condition, he possesses the characteristics which will enable him to become a highly efficient sprayer.

The old method in training an operator is nothing but a hit-and-miss coaching affair, which might, in two or three years' time, produce a man with a high rating but on the other hand, by adopting a concentrated thoroughly sound and fundamental technique, more efficiency and much quicker results will be obtained.

The next step, after analyzing a man's physical capability, and training an operator in rhythm technique, is the principle of education, and then the actual training with a gun.

First in order, is to acquaint the operator with the inner workings of a spray gun.<sup>3</sup> What is a spray gun? Principles of atomization? Types of guns? Principal parts of a gun? Types of air caps? Selection of air caps and proper alignment of gun parts? Maintenance of a spray gun?

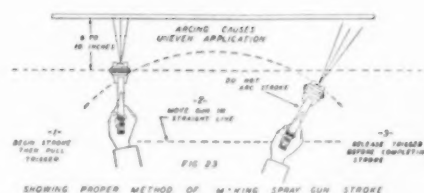


Fig. 1. The stroke is made with a free arm motion, keeping the gun parallel to the surface at all points of the stroke. The ends of the strokes are feathered out by "triggering" the gun, i.e., by beginning the stroke before pulling the trigger, and releasing the trigger just before ending the stroke. Arcing the gun results in uneven application and excessive over-spray at the ends of the stroke.

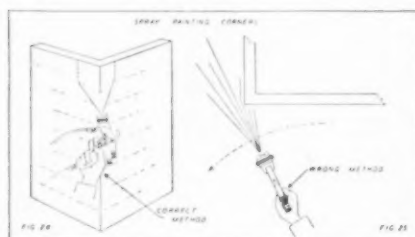


Fig. 2. Spray within 1 or 2 inches of corner. Then, holding gun sideways, catch both sides of the corner at once. Doing this otherwise wastes material and causes over-spray on the adjacent side.

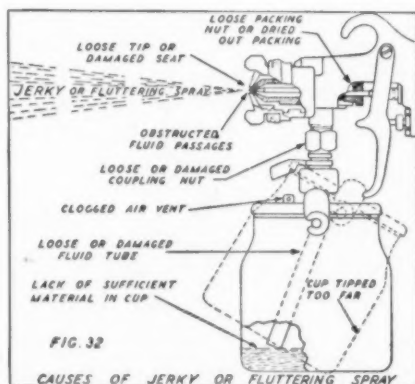


Fig. 3. Factors that cause a jerky or fluttering spray.



Fig. 4. Normal spray patterns.



### DEFECTIVE PATTERNS

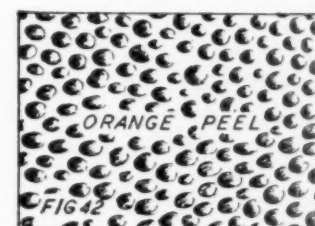
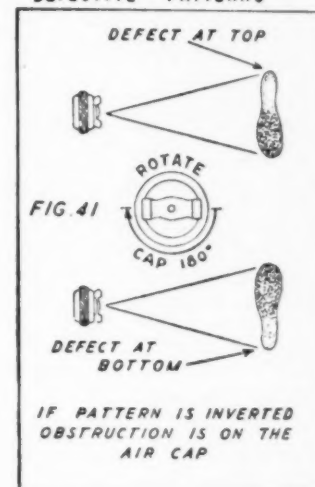


Fig. 5. Causes for defective spray patterns. Heavy top pattern (Fig. 35). Heavy bottom pattern (Fig. 36). Heavy right-side pattern (Fig. 37). Heavy left-side pattern (Fig. 38). Heavy center pattern (Fig. 39). Split spray pattern (Fig. 40).

Of course, in a few plants of the controlled finishing type (locked guns), such knowledge may not be necessary, but on the other hand, in many plants the operator is liable for repairs, but our objective is to raise the finishing personnel I.Q., to give the operator a fundamental knowledge of spray guns for repairs, if necessary, and to give



the operator a deeper insight into what he is using, doing and why.

#### Practical Education

Next, and right in line with the maintenance of spray gun, is a practical education in the operation of auxiliary equipment. They are as follows: material containers, air lines and connections, air transformers, spray booth maintenance and spray booth exhaust fans. An operator, of course, cannot spray and maintain equipment at the same time, but this is his equipment, his responsibility and he should know if things are or

are not in working order, and in many cases, a slight adjustment on his part will correct the situation.

As a suggestion to carry out this work, it would be a smart progressive idea to have set aside and out of the line of production, a small two by four spray booth which could be used to carry on this training and advanced training program. Such a set-up would pay for itself, if it were used for sales demonstration work, devising new technique in spray motion work, repair center and as well, it could be used as a convenient location for keep-

ing on hand necessary finishing data, such as thinning ratio information<sup>4</sup>, equipment replacement information (parts numbers), and finishing room operation records. This set up is nothing but a finishing room operation center. It is the focal point of operations—the brains-center.

#### Fundamentals of Spray Gun Use

After acquainting the operator with the ins-and-outs of a spray gun, and still in order, is a training in the fundamentals of using a spray gun.

The principles involved are as follows:

(a) The gun should be held perpendicular to and at the same distance from the surface being sprayed during the entire operation. As a concrete suggestion, this principle can be explained and demonstrated on paper by the use of angles, perpendiculars, horizontals and triangles<sup>3</sup>. (see illustration)

(b) The gun should be kept wide open from the beginning to the end of the operation.

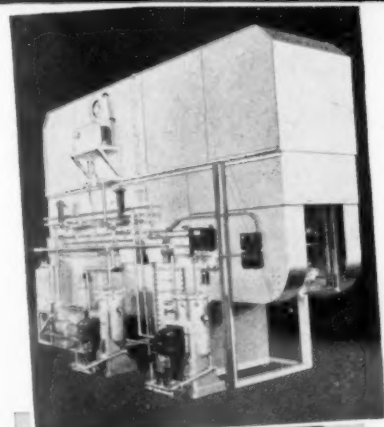
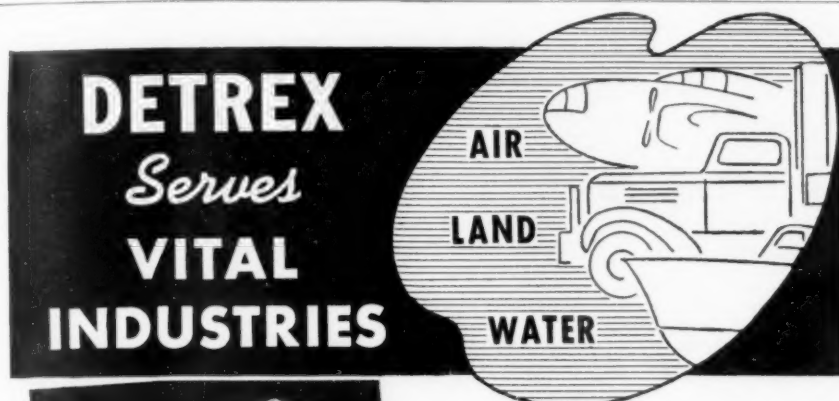
(c) The motion of the gun above the surface should be as short as possible.<sup>2, 3</sup>

Thus far our training system has been of a practical educational nature and our next step is one of actual spray work, but is still contrary to the old hit-and-miss production line system.

First in order, is an actual spray training lesson in spray gun problems and they are as follows: fluid leakage from gun<sup>39</sup>, air leakage from front of gun<sup>40</sup>, jerky or fluttering sprays<sup>42</sup>, defective spray patterns<sup>43</sup>, orange peel<sup>44</sup>, streaks in finish<sup>45</sup>, runs and sags<sup>46</sup>, mist or fog<sup>47</sup> and starving the spray gun<sup>48</sup>. This spraying should actually be defective work and could be produced by using worn out parts and plugged air caps. This is an actual and practical pre-education in defective workmanship and a training in the causes and remedies of such work.

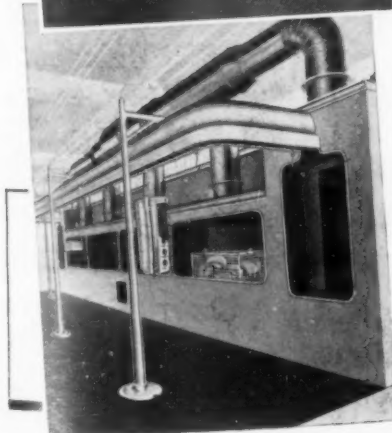
After having been given a course on trouble-shooting, the operator or trainee is next trained in the technique of spraying different types of surfaces.

First is the spraying of flat panel work and the building up of different film thicknesses, which are wet, mist, wet and full wet coats. Second, is the spraying of work which includes angles. An example would be the spraying of the insides of a square cabinet and the technique used in handling outside corners. Third, is the spray-



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ing of circular objects, such as lengths of steel pipes. Fourth, is the spraying of odd size objects or objects which are peculiar in shape.

In a program of this type, it would be economical to use a reclaimed material, or a substitute low grade organic finish in order to lower the training costs, and for the objects to be sprayed in this work, small panels and other types of surfaces, in accordance

with the outlined plan, could be used and stripped for re-use, later developing into the spraying of regular production work.

#### References

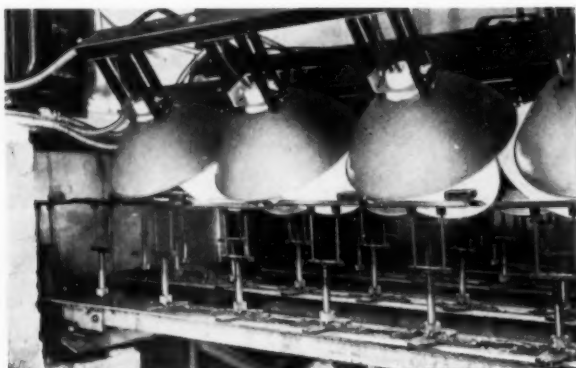
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4. "Paint and Lacquer Thinning." E. A. Zahn, Works Laboratory, General Electric Company. Industrial Finishing, September (1937), pp. 18 and 19.

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# NEW EQUIPMENT AND SUPPLIES

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## Licensing "Hot Lacquer" Process

Commercial Solvents Corp., Terre Haute, Indiana, have announced that they are now granting licenses to lacquer manufacturers and their customers under U. S. Patent No. 2,150,096 which covers the application of lacquers at elevated temperatures. This patent discloses a novel lacquer technique based on the fact that it is possible to apply at elevated temperatures, from 150 to 160°F., for example, a lacquer containing much larger proportions of solids than has ever before been possible. Because of its convenience and the marked saving in application costs which it effects, the "hot lacquer" process has been adopted by many furniture manufacturers as well as by manufacturers of a wide variety of other products including metal articles and porous materials such as wallboard.

The "hot lacquer" process allows an increase in the solids content of 50% to 60% at spraying viscosity. Also these "hot lacquers" can be applied in thicker liquid coats than conventional lacquers with the result that the number of coats required to give any desired thickness of film may be reduced by as much as one-half. Furthermore, very attractive one-coat lacquer finishes can be obtained with this new system.

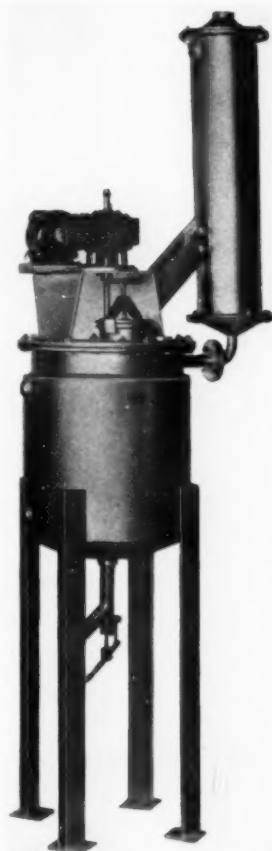
When properly formulated and applied, the flow characteristics of "hot lacquers" are excellent and blushing troubles are greatly reduced. All of these advantages are obtained without sacrificing to the slightest extent the rapid-drying and other valuable characteristics of nitrocellulose lacquers.

Inquiries concerning the "hot lacquer" process should be addressed to your lacquer manufacturer as specially formulated lacquers and special heating equipment are required when using this process.

## Mixing and Solvent Recovery Equipment

The combination stainless steel mixer and condenser illustrated here was designed and built by L. O. Koven & Brother, Inc., Jersey City, N. J., to insure speedy and thorough dispersion of a mixture of colors in a volatile medium. Since the blending operation required heat for completion, the recovery of the valuable volatile portion of the vehicle was imperative. No ordinary mixing device would do because this particular mixture, while requiring heat to blend properly, could be damaged by overheating, particularly if localized on account of dead areas caused by accumulations of the thick mixture at the bottom of the mixer.

The stainless steel mixing kettle is steam jacketed and is built for vacuum operation. On the motor driven stainless steel agitator shaft is mounted a bottom and side scrap-



Mixing and solvent recovery equipment

ing paddle shaped to avoid causing the material to pack. Another mixing paddle on the same shaft set above the scraper at a 45° angle to the vertical, tends to create a down surge in the mix.

Since the mixture tends to become quite thick at the end of the blending process, a unique type of discharge valve is used. The bottom of the agitator shaft is supported on a tripod so located that there is ample opening below it to allow the fluid to drain out freely through the quick opening flush type plug valve, thus assuring not only speedy discharge but accessibility for quick cleaning.

The volatile vehicle emitted from the heated mix passes into the condenser attached to the mixer. The condenser shell, heads, tubes and connections are all made of stainless steel.

It is apparent that this kind of unit meets not only the requirements of the lacquer manufacturer for whom it was built, but offers possibilities of practical value in the processing of chemical mixtures of all kinds, pharmaceutical and cosmetic compounds, lac-

quers, paints, organic finishes for metal and paper coatings, etc., where there are similar problems of producing delicate and sensitive, intermediate or finished materials which require not only safe, thorough and speedy mixing but also recovery of the valuable solvent. Provision for easy discharge from the kettle and accessibility for quick cleaning permit the processing of different mixtures in successive batches in the same unit.

## Finishes for Plastics

Special finishes for plastics simplify many production problems for manufacturers compelled to turn to plastics because of metal shortages due to national defense priorities, states G. Klinkenstein, Vice-President of Maas & Waldstein Company, makers of industrial finishes, Newark, N. J.

The use of these finishes enables manufacturers to make all their products out of low cost black or brown molded phenolic plastics and then finish them in any desired color and style, thus permitting standardized production without restricting the choice of finish.

To meet this newly created demand, Maas & Waldstein are supplying special finishes for plastics in all colors of both smooth and wrinkle enamels, in metallic lustres, and in hammered-metal effects.

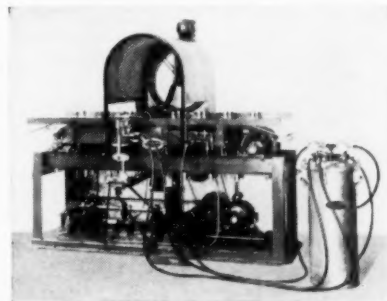
All of these finishes can be air dried or baked by either convection or radiant heat ovens, according to the manufacturer.

## Artillery Shell Sprayer

A fully automatic machine to spray coat the inside of projectiles has been built by the Eclipse Air Brush Co., 400 Park Avenue, Newark, N. J.

The machine as illustrated sprays the inside of 155 mm. shells at the rate of 500 an hour, although this same type machine can be built to handle any size projectile or other cylindrical object.

The shells are picked up by metal arms from the conveyor belt, carried along in a horizontal position on the machine to a point



Artillery shell sprayer



in front of an automatic spray gun fitted with an extension nozzle. A master switch trips the trigger on the gun as it starts to move forward, and a rotating device, with which the gun is synchronized, spins the shell to insure an even coating. As soon as the nozzle has withdrawn from the projectile, the shell moves along, making room for the next one.

At the end of the machine the metal arms deposit the sprayed shell, still in a horizontal position, on another conveyor belt.

#### New Wrinkle Finish

The Roxalin Flexible Lacquer Company, Elizabeth, New Jersey, has issued a 4 page bulletin on Rincontrol, their new wrinkle finish. This 8½ x 11 bulletin includes a sample finished panel and illustrates and describes eight exclusive Rincontrol features. Also shown are several products using this latest in textured enamel finishes.

#### Guard For Air Motored Mixer

A metal ring guard that also acts as a stand is now available on clamp-type portable Pneumix air-motored agitators made by the Eclipse Air Brush Company, 400 Park Avenue, Newark, N. J.

The ring protects the propeller from contact with the mixing vessel when in use, and provides an easy means of storage as it eliminates the necessity for suspending the mixer when not in use.



Guard for air motored mixer

The four metal supports that hold the ring in place protect the shaft and prevent its getting out of alignment.

Two metal handles alongside the air motor, at the top of the frame, facilitate lifting the agitator from the mixing vessel.

The addition of the guard in no way affects the features of the Pneumix agitators: fire and explosion-proof performance at any speed up to 6000 RPM.



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Yet the finish, a film of lacquer or synthetic, measurable only in thousandths of an inch, can be and often is the most important part of the product. In many cases it must be decorative as well as protective . . . It must be easy to apply and must give a maximum of efficiency at a minimum of cost. You will find these and many other advantages in Egyptian Industrial Finishes, each one of which is so formulated that it can be relied upon to measure up to the task for which it is selected.

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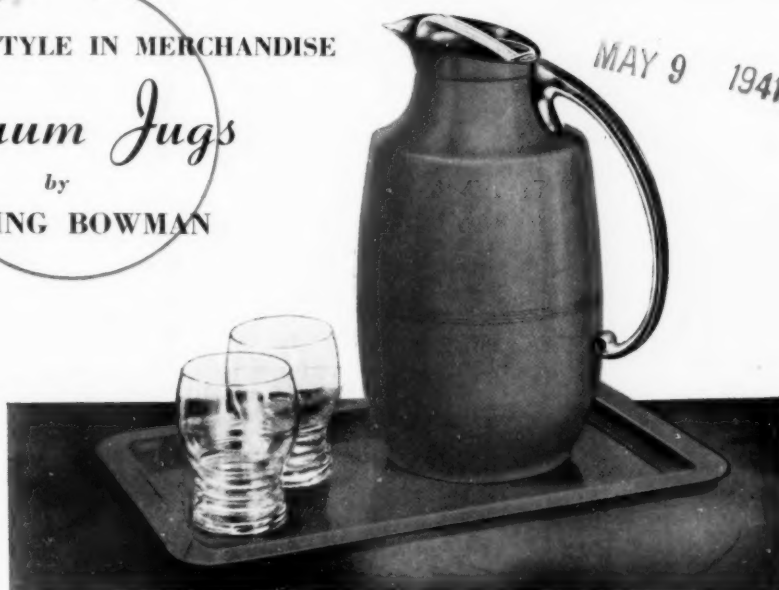
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## FACTS ABOUT ZINC

Zinc has sometimes been referred to as the "forgotten" metal, but events arising out of the European war have changed all this. The unprecedented demand for zinc which has gradually developed over the past eighteen months has attracted an unusual amount of attention and brought many calls for information.

The outbreak of the war in September 1939 prompted consumers to call for increased shipments, but it was the collapse of France in June 1940 that marked the significant change in the world zinc picture. By this time, all zinc production in Continental Europe was under the control of the Axis. This resulted in an unexpected call for American zinc from overseas, particularly from the British Empire, followed by an ever-increasing demand for the United States defense program and aid to Britain, as well as for the expanding production at home of non-defense goods.

To enumerate all the uses for zinc in Defense would require a listing of practically all the varied applications of zinc in civilian life and industry. Some, however, are especially interesting.

For instance, brass contains a substantial proportion of zinc and is used for cartridges, shells, fuses and other ordnance purposes. In addition, zinc is required in certain other non-ferrous alloys of aluminum, copper, magnesium and manganese, which are used for propellers and propeller shafts, bearings, castings, forgings and various aircraft applications. In the aggregate, these requirements will amount to many thousands of tons.

Similarly, zinc is used for plating, galvanizing or coating iron and steel for rust-proofing. Large quantities will be needed for ship construction, barbed wire, transmission equipment, powder containers, fuel cans and drums, and similar products. Tons of galvanized marine hardware and miles of galvanized pipe will be used in ships, not only for the Navy, but for the tremendous expansion of our merchant marine which is under way.

Zinc die castings, large and small, are essential elements in the assembly of aerial cameras, radio and signal equipment, tractor, truck and tank carburetors, hand grenades and other pieces of defense equipment whose parts must be dimensionally accurate.

Zinc in sheet form is indispensable in battery cans, in linings of ammunition cases, in marine boiler and hull plates, and even in lithographer's plates for the making of maps and charts.

Great Britain is undoubtedly running its smelters at capacity, while drawing supplies of the metal from sources within the British Empire, as well as from the United States. Canadian plants have materially added to their output. In all probability, Germany has more zinc smelters at her command than can be operated, with outside sources of ore cut off. Japan, it is stated, is increasing smelter production but is still seeking imports. It is also of interest to note that the Mexican smelter, which was shut down by a strike for several months, has now resumed operations, and that the bulk of this production is likely to flow into the United States or to overseas countries which otherwise would look to the United States for equivalent supplies.

During normal years our annual consumption of zinc was 540,000 tons and this consumption has been greatly increased by our defense program and the needs of Great Britain. Our zinc production, which was 478,000 tons in 1938, reached an all-time record high in 1940 of 724,000 tons, and in 1942 will probably reach close to 1,000,000 tons, taking care of all defense requirements and 75 to 80% of non-defense needs, according to the American Zinc Institute, Inc.

It would appear that, in spite of changes in the world zinc picture and particularly the additional capacity now under German control, the United States is holding its place as the largest zinc-producing nation and it is quite likely that its percentage of the world production is steadily rising above past performance.



# Laminated Plastics in the Plating Industry

By FRANK I. BENNETT

*Synthane Corp.,  
Oaks, Pa.*

Uses for laminated phenolic type plastics in the plating field are discussed. These uses include plating rack coatings, insulators, plating cylinders, tank linings, baffles, baskets, hoods and many other uses.—Ed.



Frank I. Bennett

## Introduction

**D**ESIGNERS of consumer merchandise for many years have been making increased use of synthetic plastics for molded parts where appearance and lightness in weight are of importance. Those in the industrial field, who have been using molded or laminated plastics for electrical insulation and light weight structural parts, have had the availability of plastics constantly before them in their design work.

In the field of equipment or service items, the possibilities for the use of plastics only recently have been recognized. This has been especially true in the metal finishing industry. Plating engineers in widely scattered shops have been finding new uses for plastics. One thing, however, has been noticeable. Each engineer has adopted one or two of the many uses, but few have known all of the other applications that might be of enormous help to his particular work. This article will discuss many of these uses so that a better understanding of these materials may be secured.

There are many synthetic plastics available, differing widely in quality characteristics. It is important that the most suitable type of plastic be selected. In picking a material from the plastics group, serious consideration must be

given to the kind of resin, to the material used as filler, or base, and to the structural form.

## Types of Resins

There are two general types of synthetic resins, or plastics, thermo-plastic resins and thermo-setting resins. Thermo-plastic resins are those which can be melted repeatedly without loss of any fundamental characteristics upon re-hardening. Thermo-setting resins are reacted or cured under heat and pressure and thereafter are infusible and insoluble.

The thermo-setting resins are comprised of two main types, the phenolics and the ureas. For chemical resistance and structural strength, the phenolics are superior to the ureas and will be treated at some length in this article. The phenolic resins are commercially available in molded and in laminated forms. Phenolic molded forms are produced from a molding compound consisting of a mixture of resin and powdered filler or base. The phenolic molding powder freely flows under heat and pressure and hardens

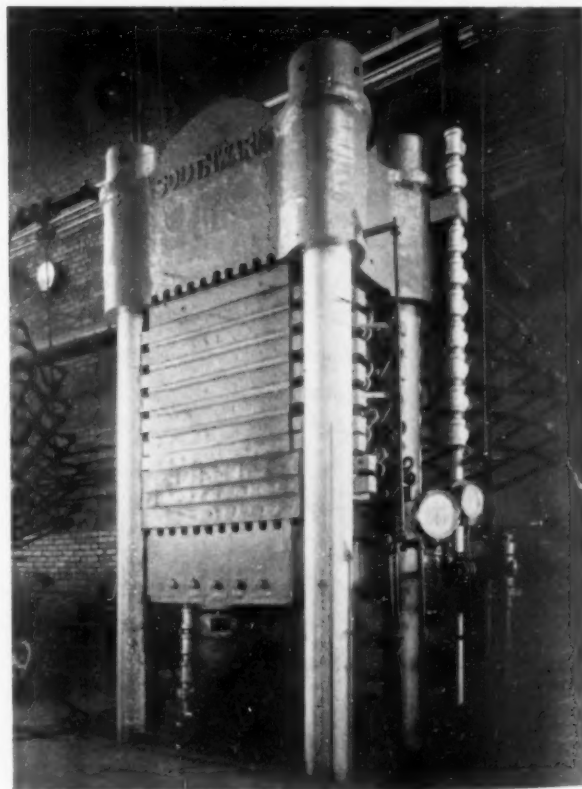


Fig. 1. Press used in making laminated sheet stock from layers of resin impregnated cloth or paper.



Fig. 2. Rod or tube press showing split molds which form rods or tubes under high pressure.

to the form of the mold, but the powdery form of the base filler produces a mechanical strength unsuited for parts where structural strength and serviceability under hard usage are required.

Laminated phenolic forms are comprised of base laminae of paper or fabric impregnated and bonded with a phenolic resinoid varnish. The basic forms of the laminated material are plates, tubes and solid rods, or simple molded forms to which the base laminae can be accommodated. The laminated plastic forms are characterized by superior structural and mechanical strength, machinability, good dielectric strength and excellent resistance to corrosion. These properties can be utilized to great advantage in the plating and cleaning of all kinds of metal where corrosion, stray currents and the plating of unwanted sections are encountered.

With the advancements in the field of laminated phenolics many important refinements and quality variations have been introduced which permit the use of these materials in the presence of corrosive liquids which originally were considered excessively destructive to all grades of resins in the phenolic group. With the careful selection of the proper type of resin and base material, the plating industry has available a product which can be used to great advantage in lowering costs and correcting undesirable conditions that have long existed due to lack of a suitable material in which are combined structural strength, insulating strength and corrosion resistant properties. Many of the important applications for laminated phenolic materials are discussed here as a guide to those who would apply this material to their own particular problems.

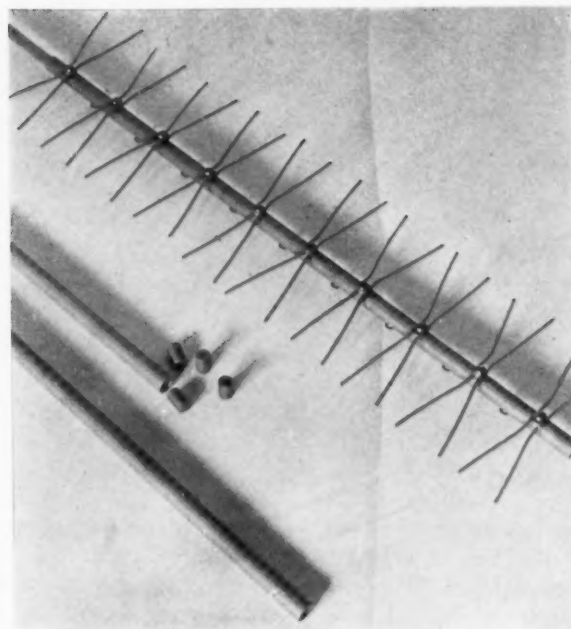


Fig. 3. Single rack showing laminated tubing and plugs used in its assembly.

### ***Plating Rack Coverings, Insulators and Supports***

Stop-off materials for plating racks include an air drying lacquer, a thermoplastic tape or a rubber covering which may be molded, dipped or electrically deposited. Each of these coverings has certain merits, the main one being that they can be applied to intricate forms if the need arises. A drawback exists in that the racks must either be sent out of the shop for treatment or excessive time is consumed in applying tape or waiting for numerous coats of lacquer to dry. Any pin-holes, or imperfections in these soft coverings will of course, start to plate and build up. Due to softness and cold flow characteristics of these coverings an increase in area of unwanted plating takes place, resulting in waste of valuable metal and increase in plating time and cost.

Laminated phenolic tubing can be used effectively as rack covering and special types are now available that are easy to apply, last for extremely long periods and are rigid enough to resist movement if any "treeing" should start at a hole or joint. The tubing is slipped over round, square or hexagonal rods and is then plugged at the end with a suitable laminated rod section, and drilled and tapped with the necessary holes for attaching the hooks or clamps. Tubing and solid rods can be carried in stock in mill length of 36" and cut to the required lengths as needed. This enables one to cover racks in various simple shapes with minimum delay.

Laminated phenolic tubing is made in two general types for the plating industry, one of which is suitable for all cleaning and plating solutions even though the preliminary steps may include a cleaning bath and plating in copper and nickel. The smooth surface of this tubing also tends to minimize "dragout" from one solution to another. Further economies can be achieved by the elimination of re-racking as in the case of chromium plating.

The cost of the tubing and plugs is low, and although the tubing does not lend itself to bending to intricate shapes, the many opportunities for economical uses more than justify the stocking of an adequate supply.

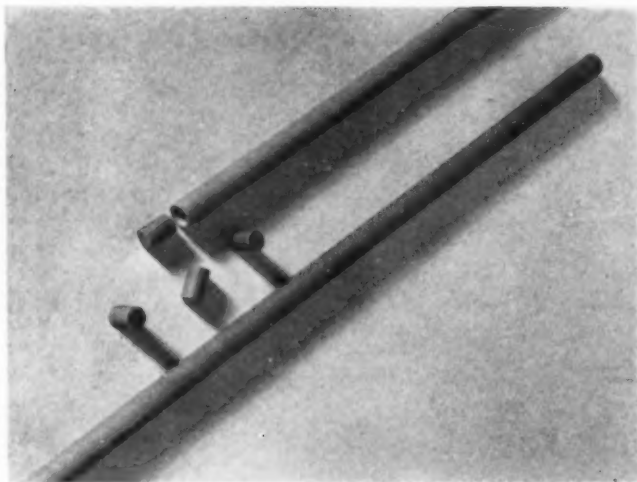


Fig. 4. Laminated tubing and plugs that can be used to make a great variety of plating racks.

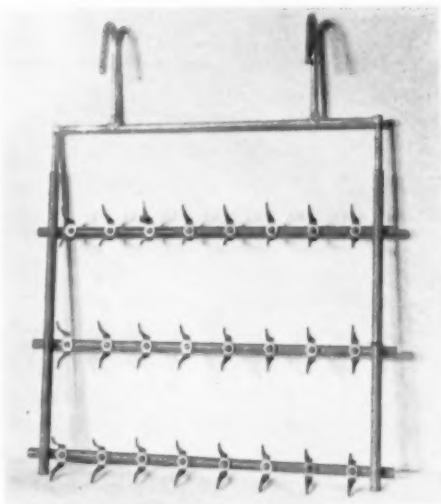


Fig. 5. Multiple type rack which can be easily assembled from brass and laminated tubing and plugs.

Laminated phenolic rack insulators and supports are used when it may be necessary to run two or more electrodes in the bath separately to obtain sufficient current density for large racks carrying heavy parts. Sheet stock is used and is machined to the required shape. In most cases fabric base material is recommended in order to secure the best combination of mechanical strength and corrosion resistance. Tubing, either fabric or paper base, may be used as a sheath to insulate heavy metal supporting members.

#### Plating Barrels

Laminated plating barrels have been used for many years in the plating industry with excellent results when care has been exercised to select materials employing the proper type and percentage of resin. It is most important that the laminated material be especially made for this use. It must have a long life, high corrosion resistance and the ability to resist the constant rubbing and impact of the work against the inside wall of the barrel. Those who make their own barrels or do their own repairing would do well to be most particular in their choice of laminated phenolic materials for this use.

#### Plating Tanks

Laminated phenolics have several interesting applications in plating tanks for such uses as baffles, insulators, supports, liners, air agitators and piping. Baffles are used to keep racks or the work from short circuiting the wall of the tank, causing a leak, or to divert the flow of solutions from agitators or steam pipes. There are many insulator applications such as bus bar insulation, electrode holders, bus bar conduits and pipe connections for insulating the solution from incoming grounded pipes.

Air agitators for bright nickel solutions are successfully made of laminated piping. They last longer and are far superior to fragile glass or to metal which might contaminate the entire solution and reduce the efficiency of bright nickel process. Phenolic piping in tanks is used to convey the solutions to filters or for recirculation and agitation with liquid rather than air.

Phenolic supports under tanks are used to eliminate stray currents. Tank linings of laminated phenolics cannot be applied as a continuous coating such as paints or semi-plastic coatings, but plate stock is being used to line the bottoms and ends of nickel tanks to facilitate the removal of sludge. Cleaning the smooth surface of the phenolic plate is a simple matter compared to the arduous task of emptying the tank and scraping the sludge from between the bricks or other rough materials used in tank construction.

Again the prospective user must be cautioned that any one type of phenolic material will not stand up in all the different types of plating solutions. Care must be used before proceeding with the job and the supplier should be consulted in advance in regard to the exact application. As a general rule, laminated phenolic materials may be used in the usual nickel and bright nickel baths with the expectation of a satisfactory period of service. However, the reverse is true of continuous immersion in chromic acid solutions, as its life will be very short. We encounter here a condition which is met so many times in corrosion studies; i.e., a material may be perfectly satisfactory or even superior for intermittent exposure but very poor when the exposure is continuous.

#### Miscellaneous Applications

There are many other uses of laminated phenolics in the plating shop. Plating and cleaning baskets, splash shields, plating masks, and sand-blast shields are of interest as they make various results possible that would otherwise be difficult to obtain. Baskets are used for cleaning in solutions, vapor degreasing and for the actual plating of odd shaped pieces. Splash shields are used in exhaust hoods and around tanks to protect metal or wood against corrosive fumes and chemicals. Plating masks are necessary where finely machined surfaces such as the interior of large sections must not be plated. Sand-blast shields have a similar function and are supplied in a rubber surfaced construction which will withstand the blast for a remarkably long time.

There are doubtless many more applications for this versatile material in the finishing of metals. Those who are operating plants of this type would do well to investigate the possibilities of laminated phenolic sheets, rods, and tubes for improving and making more economical the production of high quality work.



# Zinc Reduction Method for the Determination of Iron

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SEVERAL methods have been used in this laboratory for the reduction of ferric iron with zinc and subsequent titration of the ferrous iron with a standard oxidizing agent. One method is to add granular zinc to a sulfuric acid solution of ferric iron in a beaker or an Erlenmeyer flask, allow the reaction to continue until all the iron is reduced, remove the undissolved zinc by filtering through a Gooch crucible containing a mat of asbestos covered with a thin layer of zinc, and titrate the ferrous iron in the filtrate with standard potassium permanganate solution.

Another procedure is the well known Jones reductor method<sup>1</sup>, the description of which can be found in any textbook of quantitative analysis. Some of the chief objections are the necessity of purchasing a special column with stop cock, the preparation of zinc amalgam, the precautions of packing the column, and finally the uncertainty of washing all the reduced substance from such a large amount of zinc amalgam.

An alternative method for the reduction of iron using the column introduced for the evaluation of titanium dioxide<sup>2</sup> is suggested for the reasons of availability and inexpensive nature of the apparatus and ease of assembly. (Figure 1.)

## Reagents

Ferric ammonium sulfate, c.p. reagent grade.

Zinc, 20-30 mesh, c.p. reagent grade.

Potassium permanganate, approximately 0.1 and 0.05N solutions prepared in the usual way and standardized against sodium oxalate.

Stannous chloride solution, 150 grams of iron-free stannous chloride in 1 liter of 1:2 hydrochloric acid.

Zimmerman-Reinhardt solution, 70 grams of manganese sulfate, 125 ml. conc. sulfuric acid, 125 ml. 85 per cent phosphoric acid, diluted to a volume of 1 liter.

## Method

Accurately weigh 0.45 to 3.5 gram samples of pure ferric ammonium sulfate and dissolve in 50 ml. of 5 per cent sulfuric acid. Place the funnel, previously packed with 20-30 mesh zinc, in the suction flask. Add through this, with moderate suction, 25 ml. of water, followed by 25 ml. of a 5 per cent sulfuric acid solution. Pour the iron solution through the reductor before the sulfuric acid solution drops below the level of the zinc column. Do not allow the

surface of the solution to fall below the upper level of the zinc column during the entire operation. Wash the reductor with three 15 ml. portions of a 5 per cent sulfuric acid, and finally with three 15 ml. portions of distilled water. Gradually release the suction and wash the funnel stem.

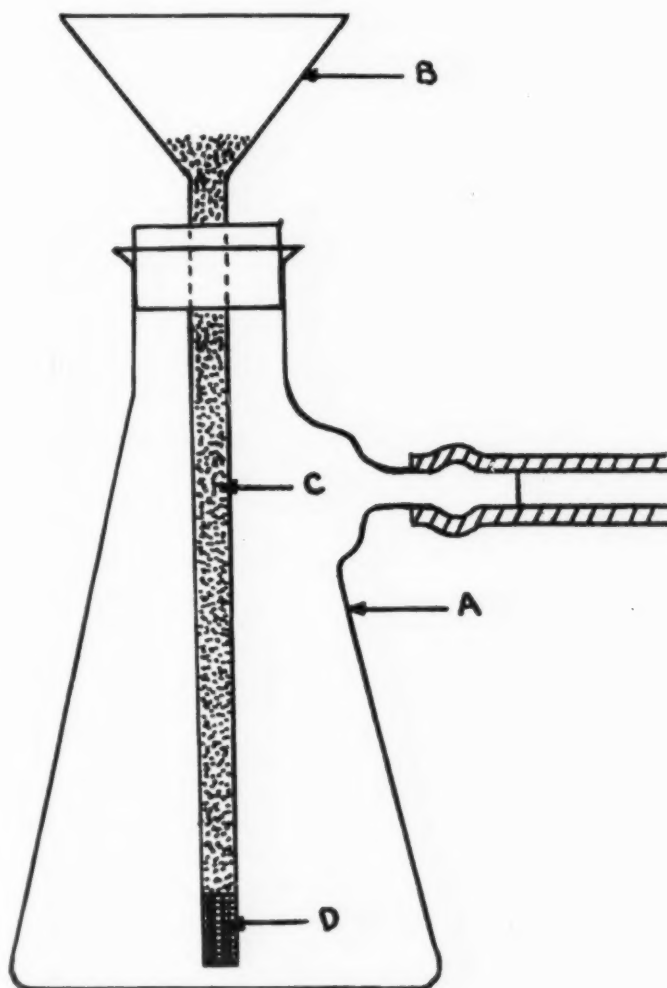


Fig. 1. Zinc Reductor.

- A. 500 ml. suction flask.
- B. 6.25-cm. conical funnel.
- C. 30 mesh zinc.
- D. Glass wool.

Add 25 ml. of Zimmerman-Reinhardt solution and titrate the ferrous iron with a standard potassium permanganate solution. Make a blank determination under the same conditions without the iron sample, and subtract this value from the original titration. Calculate the percentage of iron. The complete operation requires only a few minutes.

### Results and Discussion

The analytical results obtained by checking the stannous chloride reduction method<sup>3</sup> with the zinc reductor method are given in Table 1.

In order to test the reliability of the reductor, several columns were constructed from different size funnels. In each case the results were good. However, when shorter stemmed funnels were used, the results were consistently low. This error was corrected by adding 2 or 3 grams of granular zinc to the sulfuric acid solution containing ferric iron, and allowing the solution to stand for 2 or 3 minutes, and then poured through a reductor previously prepared by packing the stem of an ordinary conical funnel with zinc.

Certain precautions (no more severe than those required with a Jones reductor) must be observed. In preparing the zinc column, the glass wool should be well packed to avoid small pieces of zinc passing through to the solution. It is advisable to repack the funnel after about every twenty determinations. The zinc may be used again for repacking, providing it can be retained on a 30-mesh sieve.

If hydrochloric or nitric acid is present from the decomposition of an insoluble material such as iron ore or introduced by the removal of other reducible ions such as antimony, tin, copper, chromium, etc., it is advisable to convert the iron to sulfate by evaporation to fumes with sulfuric acid.

TABLE 1

Stannous Chloride Method Iron Found Gram	Reductor Method Iron Found Gram
0.4358	0.4358
0.4358	0.4361
0.2911	0.2911
0.2911	0.2911
0.2072	0.2072
0.2072	0.2072
0.1211	0.1211
0.1211	0.1211
0.0857	0.0857
0.0857	0.0857
0.0584	0.0584
0.0584	0.0584
0.0527	0.0527
0.0527	0.0527

### Summary

An accurate and rapid zinc reduction method is described prior to the titration of iron with a standard oxidizing agent. Results compare favorably with the stannous chloride method. The advantages of this method compared to the Jones reductor are the elimination of the use of amalgams, availability and inexpensive nature of the apparatus, and ease of assembly.

### Literature Cited

1. Jones, C., *Trans. Am. Inst. Mining Engrs.*, 17, 411 (1889).
2. Skolnik, H., and McNabb, W. M., *Ind. Eng. Chem. Anal. Ed.*, 12, 672 (1940).
3. Hall, W. T., "Textbook of Quantitative Analysis," p. 106. New York, John Wiley & Sons, Inc., (1937).

## HINTS TO USERS OF DIE CASTINGS

Buffing and sometimes a preliminary polishing, especially at parting lines are important items in the cost of preparing die castings for plating. They can be minimized, first, by making the casting as smooth as possible and secondly—the factor which concerns the user—by avoiding scratching in handling. Careless handling or packing, or the dropping or piling of castings upon each other or letting them fall onto hard surfaces may produce scratches or dents which have to be removed by extra polishing or buffing if the blemish is not shown on the plated part.

Some purchasers of die castings arrange for them to be placed in cartons having separate spaces for each casting, when machining is required. If machining is done in the purchaser's own plant and quantities handled are sufficient, wooden trays or racks designed to keep castings from contact with each other are often used to advantage.

If a casting is to be pushed through a die, as in shaving and broaching, it should not be allowed to fall onto other

castings or onto a hard surface. Sometimes it pays to have it strike a belt which may carry it to the next operation or to an inspector or packer. In many shops, castings are advanced from operation to operation on belts, sometimes being removed and replaced several times before various operations are completed. Other shops use chain conveyors with racks made to hold the castings on pins or hooks or in trays which prevent the castings from striking each other. Plating shops exercise unusual care in handling because they know how much it costs to buff out scratches.

In the long run, the purchaser of die castings pays the bill for failures to take care or to see that care is taken in handling die castings to be plated. He can reduce the charge by insuring that reasonable care is used and the cost of so doing is likely to be much more than offset by savings in buffing and in minimizing rejects after plating is done.

# Surface Tension Measurements

## PART II

BY DR. C. B. F. YOUNG† and E. S. ROSZKOWSKI‡

In Part II of this study of surface tension measurements, observations on the ring method of determining surface tension are given.—Ed.

A Traube stalagmometer is supposed to deliver a definite volume of liquid between two calibration marks. Generally, the number of drops of liquid between the marks is dependent upon the surface tension. The drops should be estimated to a hundredth of a drop. In the tables below, a solution of  $K_2Cu(CN)_6$  and  $NiSO_4 \cdot 7H_2O$  is used at various concentrations and the number of drops delivered are noted.

Observations on the Traube Stalagmometer at 20° C.

Conc. of $K_2Cu(CN)_6$ oz./gal.	$K_2Cu(CN)_6$ * Size of Drop				Determination of No. of Drops		
	At Top		At Bottom		Scale Readings		Drops Counted
	Start	End	Start	End	Start	Finish	
7.54	20	—19	20	—16	14	17	46
					—3	—8	45
5.66	18	—18	20	—18	8	—9	45
					20	—8	45
3.77	20	—16	19	—19	20	16	44
					16	19	44
1.89	20	—16	18	—14	20	—9	44
					20	—7	43
0	14	—29	20	—16	13	15	42
					15	—18	43

\* Values given are scale divisions away from main calculation. Positive values are above and negative below the main calibration.

Conc. of $NiSO_4 \cdot 7H_2O$ oz./gal.	$NiSO_4 \cdot 7H_2O$ Size of Drop				Determination of No. of Drops		
	At Top		At Bottom		Scale Readings		Drops Counted
	Start	End	Start	End	Start	End	
28.1	19	—33	20	—23	19	1	45
					8	6	48
21.08	20	—19	19	—19	20	—19	45
					19	1	45
14.08	20	—16	18	—19	20	—2	44
					20	2	44
7.03	20	—19	17	—18	20	—18	44
					20	—2	43
0	14	—29	20	—16	13	15	42
					15	—18	43

Sample calculation of  $CuCN$  surface tension at zero concentration:

Size of drop at top	43 divisions
Size of drop at bottom	36 divisions
No. of scale divisions per drop at top	43
No. of scale divisions per drop at bottom	36
Thus part of drop above top calibration	13/43 or 0.300
Thus part of drop above bottom calibration	15/36 or 0.417
No. of drops as measured	42

Thus actual no. of drops is equal to those measured plus correction or  $42 + 0.417 - 0.300 = 42.12$

(See Figs. 7 and 8 for surface tension vs. conc. by stalagmometer.)

### Burette Type

The burette is studied as a form of a stalagmometer to measure surface tension. In this section, the form

$$\gamma = \frac{m \cdot g}{2\pi \cdot r \cdot f \left( \frac{r}{v^{1/2}} \right)}$$

is being used with the curve shown in Figure III. The rate at which the drops should be formed is under avid dispute. Mack & France<sup>3</sup> state that the drops should form at the rate of one drop per five minutes. On the other hand, manufacturers claim the rate should be about fifteen drops per minute. In this test, the latter speed is chosen as the

more practical one. The claims for the ratio  $\left( \frac{r}{v^{1/2}} \right)$  is generally between 0.76 and 1.00 and is in close agreement with generally accepted values by physical chemists.

The values as given above are so chosen that the drops formed should be of perfectly spherical shapes. The rate at which drops are formed is determined by the speed of the liquid issuing through the capillary. Other factors include vibration of the apparatus, cleanliness of the spout and air currents that may act about the spout. In the case of the burette, for a given value of the opening of the stopcock, the rate of issue of the liquid will depend upon the height of the liquid in the burette. Thus, readings were so adjusted that at the rate of approximately fifteen drops per minute, the volume of discharge was less than 5 cc. This was done to minimize the error caused by the hydrostatic head.

In the table below, the effects of different heights of liquid in the burette on the number of drops discharged is shown. Compensations for a given set of values were made for the hydrostatic head by slightly opening the cock at the bottom of the burette as the head of the solution decreased. The amount of solution coming through was adjusted to approximately fifteen drops per minute.

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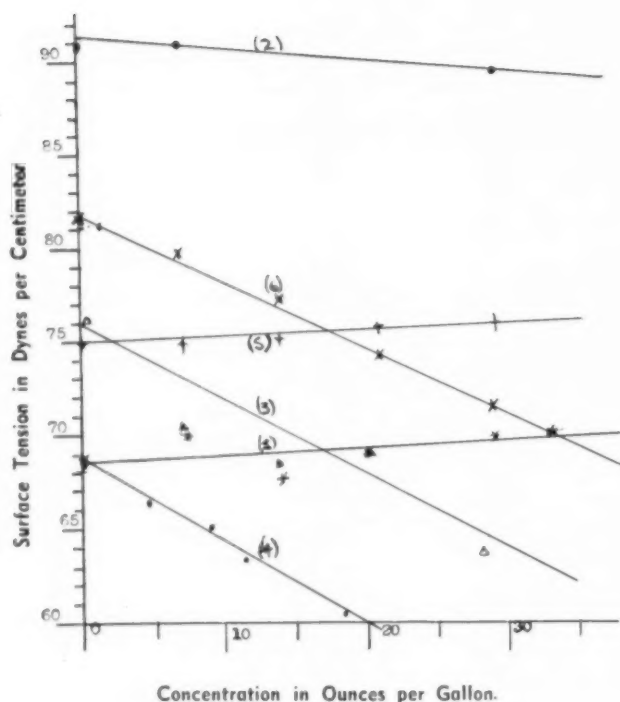


Fig. 8. Surface tension as observed for  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$  solution as a function of concentration at  $20^\circ \text{C}$ .

Curve No.	Point	Method
1	*	Capillary
2	o	Traube stalagmometer
3	$\Delta$	Burette
4	*	Du Nuoy tensiometer
5	+	Balance with platinum ring
6	x	Balance with nichrome ring

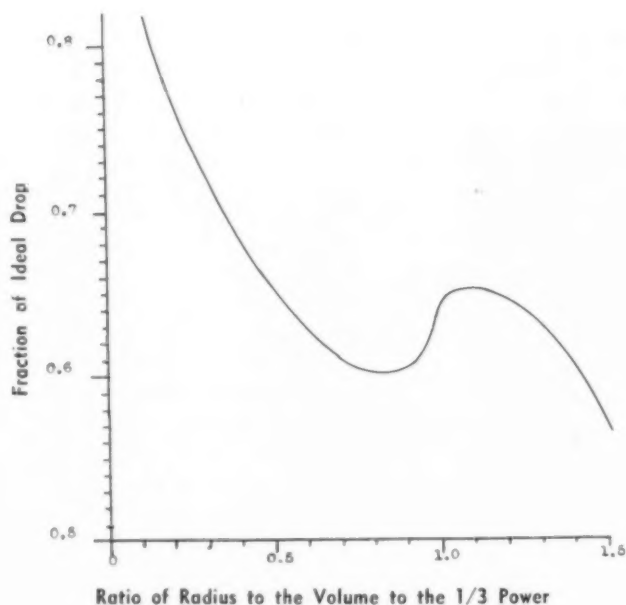


Fig. 9. Fraction of drop falling from the stalagmometer, as a function of the ratio of the radius to the volume to the  $1/3$  power after Harkins and Brown.

Effect of Burette Height on No. of Drops Formed		
Height in Burette	Volume of Distilled Water Discharged	Number of Drops Formed
0	2	40.5
10	2	40.5
20	2	40.5
30	2	40.5
40	2	40.5
48	2	40.5

This table shows that if the rate of drop formation is about fifteen drops per minute, the volume of drops formed is independent of the height of the liquid in the column. Thus at different heights in the burette, different settings of the stopcock must be obtained to give the recommended rate of discharge. If the discharge volume is small, the correction for change in height is negligible during the delivery of this small volume. Therefore no compensation with the cock is necessary.

Observations of Burette Discharge for the Determination of Surface Tension (50 drops counted) at  $20^\circ \text{C}$ .

$\text{K}_2\text{Cu}(\text{CN})_2$		
Conc. of $\text{CuCN}$ oz./gal.	Reading of burette at start in cc.	Reading of burette at end in cc.
7.54	35.03	39.39
	41.07	45.53
5.66	37.02	41.39
	43.01	47.50
3.77	38.50	47.86
	44.02	48.67
1.89	39.07	43.78
	45.00	49.76
$\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$		
28.1	40.53	45.33
	50.13	45.33
21.08	38.03	42.72
	43.03	47.81
14.08	36.01	40.62
	42.02	46.64
7.03	33.04	37.57
	38.03	42.78

Radius of tube 0.150 cm.

Sample calculation of surface tension of distilled water at  $20^\circ \text{C}$ :

$$\gamma = \frac{m \cdot g}{2\pi \cdot r \cdot f\left(\frac{r}{v^{1/3}}\right)} = \frac{980}{2\pi(0.150)} \times \frac{m}{f\left(\frac{r}{v^{1/3}}\right)} = 1030 \frac{m}{f\left(\frac{r}{v^{1/3}}\right)}$$

20 drops are equivalent to 40.5 drops

Thus, value of drop = 0.0494 cc.

$$v^{1/3} = 0.367$$

$$\frac{r}{v^{1/3}} = 0.409$$

(See Figure IX)

$$f\left(\frac{r}{v^{1/3}}\right) = 0.652$$

$$m = 0.988$$

$$\text{Thus } \gamma = \frac{(0.0494)(0.988)}{0.682} \times 1030 = 78.6 \text{ dynes/cm.}$$

(See Figs. VII & VIII for surface tension vs. conc. of burette.)

### Du Nuoy

The next methods to be studied are ring methods. The tensiometer is a well known instrument used to determine surface tensions. It consists of a sensitive torsion balance made up of a suspended taut wire, having attached

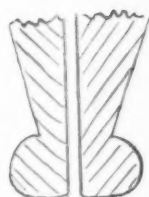


Fig. 10. Drawing of tip of stalagmometer.

to its mid-section, a lever which supports a platinum ring. The ring is suspended so that it contacts the surface of the solution to be tested. One end of the taut wire is fixed, while the other end is arranged so that a definite twisting motion can be applied. This force tends to lift the ring out of the solution and is a measure of the surface tension.

Care must be exercised in the use of this instrument. Surface tensions, as measured, could be dynamic or static. A dynamic tension is that obtained when the liquid is in a state of homogeneity. Solutions are generally composed of two different type molecules whose densities are not the same. Thus the heavier molecules tend to settle to the bottom, and the lighter molecules tend to rise to the top. If the solution is very well stirred or homogenous, at the instant of placing on the watch glass, there is no segregation of the molecules of different densities. Surface tensions taken here are known as dynamic surface tensions. Homogeneity is generally approached by constant stirring before the surface tension has been taken. As the solution is allowed to stand, a constant value is approached which is known as the static surface tension. This variation of surface tension with time is shown in Figure XI and was measured by the chemical balance with a platinum ring. This will be discussed later. The calculations from the values shown in the tables will also be shown later.

Surface Tension as a Function of Time of  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$  (28.1 oz./gal.) Solution

Time in Minutes	Reading of Bal. in Grams	Tare in Grams	Correction in Scale Divisions
0	1.561	0.759	-3
5	1.489	0.743	1
10	1.509	0.743	-3
15	1.472	0.743	-2
20	1.491	0.743	-2

According to Du Nuoy<sup>a</sup>, the following precautions must be observed in the use of the tensiometer.

Ring diameter ..... 4 cm.  $\pm 0.005$

Wire diameter ..... 0.3 mm. (0-15% Ir-Pt wire)

5 to 8 cm. diameter of liquid surface if it does not wet the watch glass.

3.5 cm. diameter of liquid surface if it does wet the watch glass.

These precautions are taken for various reasons. The ring diameter is important because the surface supported on the ring must be flat and its importance will be shown when quantitative relations are derived later. The thickness of the wire is important, because if the wire is too thin, it will not be able to support the liquid due to cutting through. The composition of the wire is important as it determines the wettability of the wire by the liquid. The diameter of the liquid surface is important, because if it is not perfectly flat, erroneous results will be obtained due to different hydrostatic heads produced due to these irregularities.

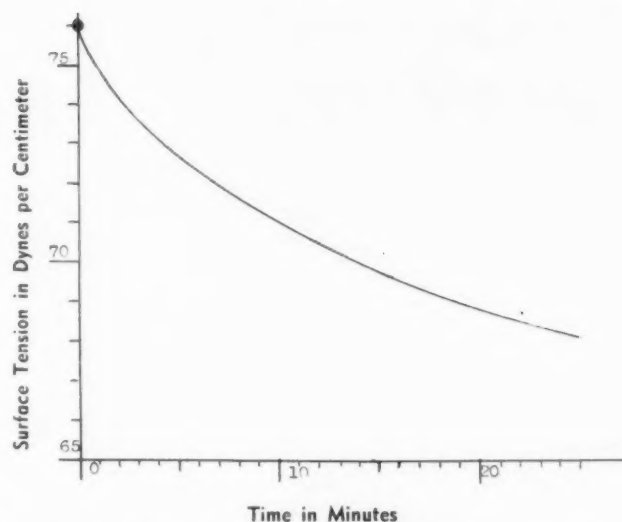


Fig. 11. Surface tension of  $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$  (28.1 oz. per gal.) solution at 20° C. as a function of time.

As mentioned, the force exerted on the ring is measured by means of a torsion wire whose torsion is calibrated on a scale. This must be calibrated. The amount of torsion that must be applied so that a certain force is exerted by the ring is determined and given in the table.

Force in Grams	Torsion in Scale Divisions
0.0	0.0
0.1	3.0
0.2	15.9
0.3	23.7
0.4	31.7
0.5	39.1

From this table it is seen that one gram is equivalent to 79 divisions on the torsion scale. Thus values as measured by the tensiometer on the scale are divided by 79 to give the force applied by the ring in grams.

From this point of calibration, the determinations are begun. The circumference of the ring is 5.997 cm. as furnished by the manufacturer and the ratio of the radius of the ring to the radius of the wire is 53.

The principle involved is that of raising a column of liquid by a ring as shown in Figure XII. When the weight of the column of liquid exceeds the surface tension, the ring will break away from the surface.

Thus, if the surface of the liquid inside the ring is not flat, incorrect surface tensions will be obtained due to the hydrostatic heads present. The weight of the column of liquid raised is  $\pi r^2 \cdot h \cdot d \cdot g$ . The surface tension is exerted around the circumference of the ring and on both

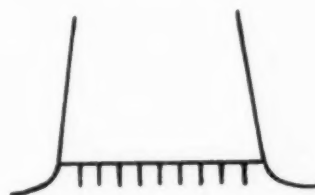


Fig. 12. Drawing illustrating ring method of determining surface tension.

sides. Thus, surface tension exerted on the ring is  $2 \cdot 2\pi \cdot r \cdot \gamma$ .

$$\text{Thus: } \pi r^2 \cdot h \cdot d \cdot g = 4\pi \cdot r \cdot \gamma$$

$$\gamma = \frac{\pi r^2 \cdot h \cdot d \cdot g}{4\pi \cdot r}$$

but  $\pi r^2 \cdot h \cdot d = \text{weight of liquid raised (W)}$   
and  $2\pi \cdot r = \text{circumference of the ring (L)}$

$$\text{thus: } \gamma = \frac{W \cdot g}{2L}$$

As the ring breaks through the surface, at times a film of liquid will adhere to it. Thus, a correction has to be applied for this film or the surface tension will be too high. This film is due to the adhesion of the liquid to the ring which is greater than the cohesion of the liquid itself.

#### Observations of Surface Tensions by Du Nuoy Tensiometer

K <sub>2</sub> Cu(CN) <sub>3</sub> Solution at 20° C					
Conc. in oz./gal.	9.6	7.2	4.8	2.4	0.0
Scale Reading in Divisions	57.9	69.7	70.8	67.8	58.5

NiSO <sub>4</sub> · 7H <sub>2</sub> O Solution					
Conc. in oz./gal.	18.2	13.65	9.1	4.55	0.0
Scale Reading in Divisions	58.3	63.7	63.1	64.6	58.5
Sample calculations for water at 20° C.					
Scale divisions	58.5				
Force exerted in grams	58.5				
	79.0				

$$W \cdot g = \frac{0.741 \times 980}{2L} = \frac{2 \times 5.997}{2L} = 60.5 \text{ dynes per cm.}$$

(See Figures VII and VIII for surface tension vs. conc. by Du Nuoy.)

#### Rings with Chemical Balance

Many electroplating plants have a chemical balance. We endeavored to use this to measure surface tension. A ring dipping into the solution was suspended from left side of the balance and weight applied. The surface tension was calculated from the weight required to break the ring away from the solution. Due consideration was given for the displacement of the beam from equilibrium conditions. The rings used were: Pt-Ir ring (10% Ir.); Cu ring; and Nichrome ring. Circumference of ring was 5.2 cm. The diameter of the Pt and Cu wire was 0.015" and the Nichrome wire was 0.020".

The beam balance is so fixed that weights on both sides of the beam will balance only when the pointer is at the zero mark of the calibrated scale as shown in Figure XIII. If the pointer is not at the zero mark, the weights on both sides of the beam will not be balanced.

The equilibrium of the balance is affected by the tortions applied to the beam by the different forces involved. The balance itself exerts a force through its center of gravity, (C). The tortions are applicable about the fulcrum (F). If the balance is in equilibrium and the pointer is at the zero mark on the scale, the line of action of the force at C passes through the fulcrum and has no effect on the torsion. Thus, the weights on both sides of the fulcrum affect the torsion. Since the arms of the balance are of the same length, the weights on both sides are equal to each other.

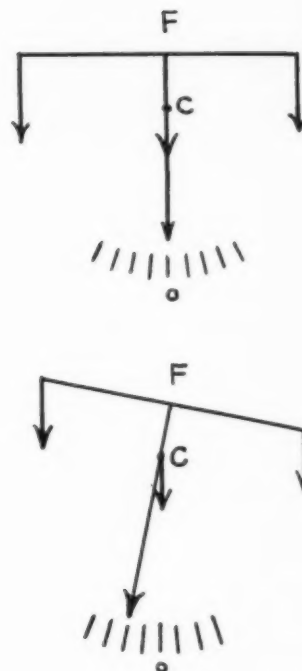


Fig. 13.

On the other hand, if the pointer is displayed as shown in the bottom part of the diagram, the line of action of force at C is to one side of the fulcrum. Thus it will affect the torsion of the balance. From force equations, it is seen that if the pointer is displaced to the left, the weight as measured is greater than the actual weight. If the displacement is to the right, the weight as measured is smaller than the actual weight. This must be considered in the measurements obtained. This effect will be known as the correction.

The determination of the sensitivity (effect above discussed) is carried out as performed in quantitative analysis. Three readings to the left and two to the right are taken for a given set as the beam oscillates. The readings to the left of the zero point will be shown as positive and those to the right will be shown as negative.

#### Observations for the Determination of the Sensitivity

Weight on Pan	Swings to the Left			Swings to the Right	
	1st	2nd	3rd	1st	2nd
3.0 mg.	8.4	6.3	5.7	2.2	3.3
	7.7	6.3	5.7	2.4	3.3
	7.8	6.4	5.8	2.6	3.3
2.0 mg.	5.8	4.9	4.6	1.1	1.8
	5.7	4.9	4.7	1.2	1.8
	5.7	5.0	4.6	1.1	1.8
1.0 mg.	3.2	3.0	2.7	0.6	0.8
	3.3	3.0	2.8	0.6	0.8
	3.4	3.0	2.8	0.5	0.8
0.0 mg.	0.3	0.3	0.3	0.0	0.0
	0.7	0.7	0.4	-0.2	-0.1
	0.3	0.3	0.3	0.0	0.1

Sample calculation of the sensitivity.

Swings to left—8.4, 6.3, 5.7

Mean swing to the left—6.80

Swings to right—2.2, 3.3

Mean swing to right—2.75

Thus equilibrium point is the mean of the two mean swings and equals 4.78.

(To be concluded in June issue)



# The Measurement of Metallic Brightness<sup>†</sup>

## PART II—Conclusion

BY DR. RICHARD SPRINGER

Laboratory, Langbein-Pfanhauser Works, Inc.,  
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### (e) Evaluation of Measurements

In evaluating the results it was found:

1. At first, the difference between the longitudinal, *L*, and the transversal, *Q*, values was found to be surprisingly high. The property perceived by the human eye as brightness was found to be caused, for the major part, by the longitudinal and in a slight degree only by the transverse values, so that the longitudinal value is paramount for the definition of metallic brightness. In spite of that fact, it is advisable to quote the transverse values besides the longitudinal ones, in brackets. Of two samples with the same longitudinal and varying transverse values, the one with the greater transverse reading impresses the eye as being duller. In some instances, it may happen that with two samples, one with a given longitudinal and a low transverse value, the other, however, with a slightly smaller longitudinal but a high transverse reading, the latter appears to the eye to be more matte in spite of the smaller longitudinal value, because the small difference in *L* is overcompensated by the great difference of *Q*. This is particularly the case with *L* readings lower than 0.4.

2. Accordingly, the longitudinal, combined with the transverse value is numerically characteristic of brightness, the "brightness value," in such a way that the longitudinal value increases with decreasing brightness. The longitudinal value indicates what percentage of the incident light is being diffusely reflected. Efforts to comprise both values into one single value met with no success.

3. The transverse value is very useful for the measurement of the condition impressed by a given polishing compound on a suitably chosen standard surface. Accordingly, the transverse value can be applied to define directly the fineness of grain of polishing and buffing compounds.

4. The softer the polished deposit or the polished base, the higher the transverse value is generally found to be. The so-called "haze" on polished soft metals, such as zinc and cadmium, sometimes coincides with a relatively high transverse reading.

5. A reliable definition of a given impression of brightness requires, besides the brightness value:

a. Statement of the metal; b. Statement of any preliminary treatment of the base; c. Statement whether or not it is lacquered.

6. By separating the longitudinal values of the table of experiments according to the metals, preliminary treatment, and the lacquer, and arranging them by their increasing longitudinal values, a practically complete correlation

is found between the measured values and the visual judgment, as is indicated by the tables.

### (f) Arrangement of Results of Measuring by Longitudinal Values and Visual Judgment

Table 1 shows that the arrangements of the specimens by their increasing longitudinal values or, with constant longitudinal values, by their increasing transverse values, practically corresponds to the visual evaluation. Only one exception was found, No. 14 and 15. Two deposits, both almost matte, one of which was found by four observers to be slightly brighter than the other, appeared by measurement to be somewhat duller. No explanation could be found for this phenomenon. This deviation is of no particular disadvantage as far as practical purposes are concerned, because at that particular point, that which was to be measured, namely brightness, was practically no longer existent. The visual evaluation was conducted by two observers. In cases of doubt, a third and sometimes a fourth observer was also consulted. Deposits on entirely different bases or on bases of varying pretreatment or lacquered deposits do not fit into the above arrangement, that is, the measured values deviate from the visual evaluation in the arrangement. But even these sets of samples could be correspondingly arranged within the respective groups, as is shown in the following tables.

It cannot, however, be explained why one nickel deposit out of a citric acid bath could not be correspondingly arranged in the scheme.

Table 3: It will be found that deposits on a base which has not been pretreated can just as well be easily arranged in an order strictly corresponding to the visual findings. Even chromium deposits could be so arranged, which is not possible with a pretreated or polished base. Furthermore, it is interesting to find that the ratio of the longitudinal to the transverse values indicates the degree of treatment with high accuracy. Sample No. 43 dull nickel plated on wrought copper and also correspondingly dull chromium plated had identical *L* and *Q* values.

Table 4: The pumiced samples of different metals could just as naturally be arranged in correlation with the visual judgment.

Pumiced surfaces had lower *L* values, when compared with polished metals, than was to be expected by visual evaluation. Relatively high *Q* values are specific for pumiced surfaces.

Specimens of Tables 5a and 5b could not be arranged the

<sup>†</sup>Translated by Dr. Walter R. Meyer from "Zeitschrift für Elektrochemie," 46, 3-13 (1940).

TABLE 2

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement
1	0.06	3.2	Nickel deposit, highly polished	38	38
2	0.06	10.8	Nickel deposit, polished, on polished copper	23	23
3	0.06	16.6	Nickel deposit, polished, on polished copper	24	24
4	0.07	3.9	Bright nickel deposit, polished	36	36
5	0.1	10.7	Bright nickel deposit	33	33
6	0.14	3.7	Bright nickel deposit on polished copper	26	26
7	0.14	6.4	Bright nickel deposit on brass	34	34
8	0.4	3	Bright nickel deposit on polished copper	25	25
9	0.5	4.3	Bright nickel deposit, untreated	32	32
10	0.58	7.4	Bright nickel deposit, untreated	30	30
11	0.96	2.6	Bright nickel deposit, untreated	31	31
12	5.8	8.2	Nickel deposit out of highly effective bath, untreated, 1 A/dm <sup>2</sup> , 30 min.	28	28
13	7.5	12.8	Deposit out of usual nickel bath, untreated, 1 A/dm <sup>2</sup> , 30 min.	27	27
14	7.7	10.8	Usual nickel deposit, untreated	35	29
15	10.0	12.5	Nickel deposit out of highly effective bath, untreated, 0.75 A/dm <sup>2</sup> , 1 hour	29	35
16	18	25.7	Nickel deposit on polished copper, untreated	21	21

TABLE 3  
Deposits on Crude Copper Sheet

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement. Judgment Based on Corr. No. of Table 1
1	0.19	33.2	Nickel deposit, highly polished and chromium plated	46	46
2	0.2	4.8	Bright nickel deposit, polished	20	20
3	0.4	26	Nickel deposit on crude copper sheet, polished	17	17
4	0.5	18.3	Nickel deposit on crude copper sheet, polished	18	18
5	0.94	12.5	Nickel-chromium deposit on crude copper, nickel highly polished	45	45
6	1.9	4.2	Bright nickel deposit on crude copper sheet, untreated	19	19
7	20.7	20.7	Nickel-chromium deposit on crude copper, nickel and chromium unpolished	43	43
8	26.5	32	Nickel deposit on crude copper sheet, untreated	15	15

TABLE 4  
Metal Deposits, Pumiced

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement. Judgment Based on Corr. No. of Table 1
1	1.5	120	Nickel deposit on polished copper, scratched with powdered pumice on brush	22	22
2	2.2	16.7	Nickel-chromium deposit on polished copper, nickel scratched with powdered pumice on brush	43	43
3	3.5	73	Nickel-chromium deposit on crude copper sheet, nickel scratched with powdered pumice on brush	44	44
4	3.6	44	Brass sheet, scratched with powdered pumice on brush	9	9
5	5.7	31.8	Brass sheet, scratched with powdered pumice by hand	8	8
6	8.7	43	Copper sheet, scratched with powdered pumice on brush	3	3

**TABLE 5A**  
**Lacquered Bright Nickel Deposits on Polished Base**  
**Arrangement by Longitudinal and Transverse Values**

Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement. Judgment Based on Corr. No. of Table 1
1	1.0	8.3	Bright nickel deposit on polished copper sheet, buffed and lacquered	42	42
2	1.2	3.9	Bright nickel deposit on polished copper sheet, unpolished but lacquered	41	41

**TABLE 5B**  
**Lacquered Bright Nickel Deposits on Untreated Base**  
**Arrangement by Longitudinal and Transverse Values**

Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement. Judgment Based on Corr. No. of Table 1
1	0.9	8.0	Bright nickel deposit on crude copper sheet, polished and lacquered	40	40
2	2.3	7.4	Bright nickel deposit on crude copper sheet, unpolished but lacquered	39	39

**TABLE 6**  
**Chromium Deposits**

**Arrangement by Longitudinal and Transverse Values**

Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement. Judgment Based on Corr. No. of Table 1
1	0.06	3.2	Nickel-chromium deposit on highly polished brass	52	52
2	0.08	3.0	Nickel-chromium deposit on highly polished brass, chromium highly polished	51	51
3	0.19	44.8	Nickel-chromium deposit on polished copper, nickel highly polished.	50	50
4	0.24	31.7	Nickel-chromium deposit on polished copper, nickel polished	49	..
5	0.4	17	Chromium deposit on polished brass	57	..
6	0.4	36	Chromium deposit on polished brass	55	..
7	0.5	21.3	Chromium deposit on polished brass	54	..
8	0.62	10.8	Chromium deposit on polished brass	56	56
9	0.9	25.2	Chromium deposit on polished brass	53	53
10	6.6	7.3	Nickel-chromium deposit on polished copper sheet, nickel unpolished	47	47

**TABLE 7**  
**Zinc Deposits**

**Arrangement by Longitudinal and Transverse Values**

Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table 1	Visual Arrangement. Judgment Based on Corr. No. of Table 1
1	0.25	54	Bright zinc deposit, highly polished	63	63
2	0.25	113	Bright zinc deposit, lightly polished	62	64
3	0.6	43.3	Bright zinc deposit, slightly polished	64	62
4	1.9	6.7	Bright zinc deposit, unpolished	65	65
5	2.1	7.3	Bright zinc deposit, untreated	61	61
6	24.7	37.7	Matte zinc deposit out of an alkaline bath, 1 A/dm <sup>2</sup> , 20 min., untreated	74	74



**TABLE 8**  
**Cadmium Deposits**

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table I	Visual Arrangement. Judgment Based on Corr. No. of Table I
1	0.7	60	Bright cadmium deposit	66	66
2	0.7	103	Bright cadmium deposit, polished	67	68
3	0.9	90	Bright cadmium deposit, highly polished	68	67
4	1.2	57.6	Bright cadmium deposit, polished	70	70
5	2.4	7.6	Bright cadmium deposit out of different bath, unpolished	69	69

**TABLE 9**  
**Silver Deposits**

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table I	Visual Arrangement. Judgment Based on Corr. No. of Table I
1	1.0	101	Silver deposit, lightly polished	59	60
2	1.12	60.7	Silver deposit, highly polished	60	59
3	49	70	Silver deposit, matte	58	58

**TABLE 10**  
**Tin Deposits**

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table I	Visual Arrangement. Judgment Based on Corr. No. of Table I
1	0.85	27.3	Tin deposit, highly polished	73	73
2	3.0	55.3	Tin deposit, scratched at the circular scratch brush	72	72
3	46.3	46.3	Tin deposit, matte, untreated	71	71

**TABLE 11**  
**Copper**

Arrangement by Longitudinal and Transverse Values					
Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table I	Visual Arrangement. Judgment Based on Corr. No. of Table I
1	1.0	52	Copper sheet, highly polished	5	5
2	1.3	104	Copper sheet, lightly polished	4	4
3	9.2	48.3	Copper sheet, untreated	1	1
4	15.3	74.6	Copper sheet, scratched with powdered pumice by hand	2	2
5	40	57	Copper deposit on iron, out of a matte potassium cyanide bath	6	6

same by measurement as by the eye, as the base influences the impression of brightness, even if lacquered subsequently, a fact that was to be expected.

Generally it was found that lacquering increases the L values of polished samples, supposedly caused by higher diffuse reflectivity at the surface, which, in turn, makes for deviation from the visual judgment.

Table 6: Samples Nos. 4 to 7 appeared to be approximately equal to the eye, i.e., the arrangement of these four

samples by increasing brightness as found by four different observers, led to contradicting values. The reason is, that in such cases, the method of measurement is more accurate than the eye, the Pulfrich photometer indicating differences in brightness which are too slight to be perceived by the eye.

Chromium deposits cause too low longitudinal values when compared with nickel deposits of the same brightness, if judged visually, with the bluish tint characteristic of chromium and the yellowish tint peculiar to nickel, can be

TABLE 12  
Brass

Arrangement by Longitudinal and Transverse Values

Order Number	L Value	Q Value	Kind of Deposit	Corresponding No. of Table I	Visual Arrangement Judgment Based on Corr. No. of Table I
1	0.2	62.3	Brass sheet, highly polished	11	11
2	0.3	72	Brass sheet, lightly polished	10	10
3	0.9	48	Brass sheet, commercially polished	12	12
4	7.1	189	Brass deposit on pumiced iron, 0.3 A/dm <sup>2</sup> , 30°C (86°F.)	13	7
5	7.8	24	Brass sheet, untreated	7	13
6	8.4	232	Brass deposit on pumiced iron at 0.9 A/dm <sup>2</sup> , 20°C (68°F.)	14	14

explained by the use of a red filter in measuring.

Table 7: Visual evaluation reversed Nos. 2 and 3. This deviation appears obvious at first glance, by taking into account the fact that great differences in the Q values tend to overcompensate slight differences in L values.

Table 8: The discrepancy of Nos. 2 and 3 may possibly be explained by the Q values, as is the case with zinc deposits.

Table 9: Here also the deviation of Nos. 1 and 2 is explicable by the Q value.

Tables 10 and 11: Complete agreement between the measured values and the visual findings.

Table 12: The deviation of Nos. 4 and 5 is to be explained by the high difference in Q values. The extremely high Q value of No. 14 is noteworthy. A special structure of the scratch lines, caused by pumicing, seems to direct also part of the specularly reflected light into the object glass.

(g) Measurement of Effect on Aluminum of Various Matte Dips

In order to put the measurement of brightness to a practical test, it was sought to find out to what degree some commercial matte dips for aluminum were more effective than others. The experiments were made at a temperature of 30° C. (176° F.) varying the duration of the dips. The following L values and losses in weight were found:

Dip No.	Duration of dip, in min.	L value found	Loss in weight in mg/dm <sup>2</sup>
I	1/2	11.2	112
	1	15.0	231
	3	30.7	833
II	1/2	13.3	135
	1	19.1	309
	3	35.3	943
III	1/2	15.7	101
	1	22.5	250
	3	30.1	683

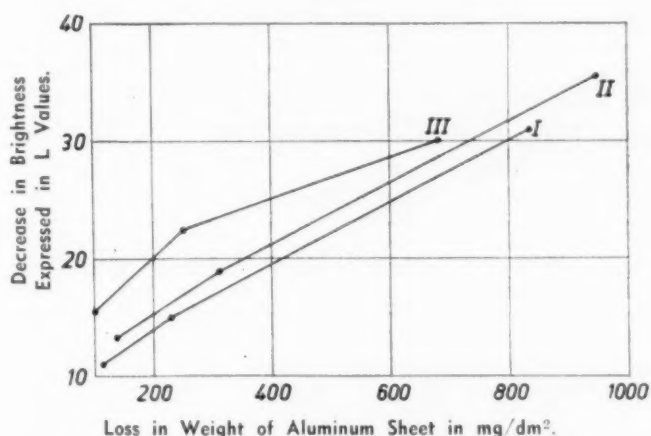


Fig. 3. The Effects of Various Etching Solutions on Aluminum.

(In order to convert the values expressed in mg/dm<sup>2</sup> into oz./sq. ft. multiply the corresponding figures by the factor 0.000328)

The L values and losses in weight are graphically shown in Fig. 3.

The diagram shows clearly that under given experimental conditions, dip III has a higher matte effect, with the equal loss in weight of metal, as compared with dips I and II.

## VI. Summary

The results of the experiments are as follows:

1. The photometric method, as described above, based on the measurement of the diffusely reflected light at an incident angle of 45° makes a reliable and precise definition of all effects of brightness possible, provided the kind of metal, surface treatment and lacquer coats are stated.

2. Ratio of the Q value to the L value is a measure for the "stroke" of a polish.

3. The method is applicable for all purposes stated in part III.

4. The simplicity of application makes the method described, particularly suitable for industrial purposes.

# Separate Standing Committee on Electroplating Organized By American Society for Testing Materials

## Personnel Announced—Actions on Standards

With the organization by the American Society for Testing Materials of the new Committee B-8 on Electrodeposited Metallic Coatings, effected during A.S.T.M. Committee Week in Washington in March, plans that had been under discussion last year on realignment of the Society's work on electroplating have been put into effect. Probably the first work carried on by the Society in this field was that by Committee A-5 on Corrosion of Iron and Steel. As a corollary of its work on exposure tests of coated iron and steel, the committee developed specifications for coated products. Similarly, Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys reached the point where it believed that the specifications for various coated non-ferrous materials should be prepared and work was initiated with this in view. Committee B-6 on Die-Cast Metals and Alloys was also interested in the plating of die-cast products. In view of the common interest of these several committees, it was felt that the work could be handled more efficiently if it were segregated in a separate committee since the problems incident to the several materials had a great deal in common. After consultation with the various committees, a new committee on electroplating was accordingly authorized by the Society's Executive Committee, the preliminary statement of scope being as follows: The formulation of specifications and methods of test for electrodeposited metallic coatings with the exception of zinc and cadmium applied to steel.

A steering committee consisting of *E. A. Anderson* (chairman), *William Blum*, *W. H. Finkeldey*, *C. H. Sample*, *Sam Tour*, and *J. R. Townsend* assisted the Executive Committee in the selection of the initial personnel. Mr. Anderson was designated temporary chairman and under his guidance organization was effected, with the election of the following committee officers:

*E. M. Baker*, chairman, Prof. of Chemical Engineering, University of Michigan, Ann Arbor, Mich.

*E. A. Anderson*, vice-chairman, New Jersey Zinc Co., Palmerton, Pa.

*Gustaf Soderberg*, secretary, Technical Director, The Udylyte Corp., Detroit, Mich.

A list of the personnel at this time follows:

Aluminum Co. of America, *J. J. Bowman*

American Brass Co., *A. W. Tracy*

American Chain & Cable Co., Inc., *B. Westerman*

American Electroplaters' Society, *A. B. Wilson*

*E. M. Baker*, University of Michigan

Bell Telephone Labs., Inc., *H. G. Arlt*—*C. H. Sample*, Alternate

*William Blum*, National Bureau of Standards

Bridgeport Brass Co., *W. E. Baulieu*

Carnegie-Illinois Steel Corp., *E. S. Taylerson*—*R. A. Dimon*, Alternate

Chase Brass & Copper Co., Inc., *B. H. McGar*

Crane Co., *R. H. Zinkel*

Dochler Die Casting Co., *J. C. Fox*

du Pont de Nemours & Co., Inc., *E. I. Grasselli* Chemicals Dept.,

*L. R. Westbrook*

*W. H. Finkeldey*, Singmaster & Breyer

General Electric Co., *W. L. Maucher*

General Motors Corp., *W. M. Phillips*

*A. K. Graham*, Jenkintown, Pa.

*C. E. Heussner*, Chrysler Corp.

*G. B. Hogaboom*, Hanson-Van Winkle-Munning Co.

International Nickel Co., Inc., *R. J. McKay*

*Glen F. Jenks*, U. S. Army, Ordnance Dept.

*Charles A. Marlies*, College of the City of New York

New Jersey Zinc Co., *E. A. Anderson*

Scovill Manufacturing Co., *W. B. Price*

*Erwin Sohn*, Standard Sanitary Manufacturing Co.

*Sam Tour*, Lucius Pitkin, Inc.

Udylyte Corp., *Gustaf Soderberg*

U. S. Navy, Bureau of Ships, Navy Dept., *E. C. Forsyth*—

*K. D. Williams*, Alternate

U. S. War Dept., Quartermaster Corps, *A. J. Buckley*

Western Electric Co., Inc., *A. M. Wagner*

In connection with certain organization problems and to expedite committee work, an Advisory Committee was set up at the meeting to consist of the newly elected officers and the members of the steering committee.

The following specifications, formerly under the jurisdiction of Committee A-5, have been assigned to this new committee:

Tentative Specifications for Electrodeposited Coatings of Nickel and Chromium on Steel (A.S.T.M. A 166—40 T)

Tentative Methods of Test for Local Thickness of Electrodeposited Coatings on Steel (A.S.T.M. A 219—40 T)

The committee took under immediate consideration standards that have been under development in Committee B-3 and it is proposed to recommend at the A.S.T.M. annual meeting in June proposed new specifications covering:

Electrodeposited Copper-Nickel-Chromium Coatings on Zinc and Zinc Base Alloys

Electrodeposited Nickel-Chromium Coatings on Copper and Copper Base Metals

There was considerable discussion as to the type of subcommittee organization that should be set up. These subcommittees could either be according to type of coating, type of base material, or according to the use of the material. This question will receive further consideration at a future meeting of the committee. Approval of a final statement of the committee's activities will also await action sometime in the future.



# Electrochemical Society Meeting

## Held at Cleveland

The 79th meeting of the Electrochemical Society was held April 16-19 at Cleveland, Ohio.

Professor Victor F. Hess of Fordham University, discoverer of the Cosmic Rays and Nobel Laureate, presented his findings on the electric discharges through the atmosphere as they affect the formation of ozone and radio communication. Another topic of nationwide interest was the electrical properties of selenium and cuprous oxide films used in many thousands of photocells and rectifiers.

Professor G. L. Clark and Dr. P. G. Roach of the University of Illinois reported upon findings of their x-ray studies of these active films, important among which was the fact that impurities in selenium films are not as harmful as heretofore suspected to be.

New applications and new studies of high frequency currents were demonstrated by Dr. E. M. Guyer of the Corning Glass Works. Glass can readily be "welded" by high frequency currents which was heretofore considered impossible. H. B. Osborn, Jr., of the Ohio Crankshaft Company described the application of induction heating to local surface hardening of various steel parts, notably crankshafts. A half dozen papers were devoted to the storage battery and its performance and new methods for its better control. There was a total of twenty-five papers presented covering almost every phase of electrochemistry.

Professor F. C. Mathers of the University of Indiana delivered his presidential address on Thursday evening. The topic of his address was "Adventures in Electroplating."

The thirteenth award of the Weston Fellowship of \$1000 was made to Rodney E. Black of Pawhuska, Okla. Mr. Black is working at the University of Wisconsin on the investigation of the various baths for the plating of molybdenum and tungsten alloys with special interest in the organic amine baths. His work will be continued at the University of Wisconsin under the direction of Professor M. L. Holt.

The Society's Prize to Young Authors was awarded to Dr. Johnstone S. Mackay of Prospect Park, Pa., for the paper entitled, "Photoelectric Cells Sensitive to Long Wave Length Radiation," of which he was co-author. Dr. Mackay is with the Sun Oil Company, Marcus Hook, Pa.

Officers of the Society for 1941 are as follows:

President: Raymond R. Ridgeway, The Norton Co., Chippawa, Ont., Can.

Past President: Professor Frank C. Mathers, Dept. of Chemistry, Indiana University, Bloomington, Ind.

Vice-Presidents: E. M. Baker, G. B. Hogaboom, Sr., M. deK. Thompson. Terms expire 1942. Sherlock Swann, Jr., J. W. Marden, Malcolm Dole. Terms expire 1943.

Treasurer: R. M. Burns, 463 West Street, New York. Term expires 1942.

Secretary: Dr. Colin G. Fink, 3000 Broadway, New York. Term expires 1942.

Abstracts of the technical papers presented at the meeting follow.

### Abstracts of Technical Papers

#### SEMI-CONDUCTOR PHOTOCELLS AND RECTIFIERS

By COLIN G. FINK AND EDWARD ADLER

One of the most interesting products of photoelectric researches during recent years is the semi-conductor cuprous oxide cell. Numerous attempts have been made in the past to satisfactorily interpret the phenomena involved, but so far, due largely to variables not under proper control, experimentally all attempts have failed. One of these variables is the cuprous oxide film. Time and again this has been prepared thermally under apparently identical conditions and yet

the behavior of the oxide and the performance of the cells in which this oxide was incorporated showed wide variations. To date, the best method of producing the photoactive cuprous oxide film or layer has been by thermal oxidation of a copper metal surface. In view of the ease with which cuprous oxide can be produced electrolytically (the red "antifouling" pigment is thus produced commercially) it naturally followed that the electrolytic method with its close control of operating conditions deserved more intensive study in the preparation of light-sensitive layers on copper. However, all electrolytic experiments in the past carried out at Columbia and elsewhere failed to evolve an active cuprous oxide in spite of the wide physical variety of cuprous oxide produced.

Recently a patent\* was published which described deposits com-

\* Stareck, U. S. Pat. 2,081,121 (May 18, 1937).

posed primarily of cuprous oxide. Upon investigation these deposits proved to be photoactive—in other words these were the first electrolytic cuprous oxide deposits which showed appreciable response when exposed to radiation.

One of the fundamental advantages of the electrolytic cuprous oxide film as compared with that produced thermally is the ease with which the thickness of the electrolytic cuprous oxide film or layer can be reproduced and developed to any predetermined desired thickness. Furthermore, films of micron thickness can be produced and reproduced electrochemically but not thermally. This is of particular importance from a theoretical as well as a commercial point of view. Heretofore with the thermally produced oxide the control of film thickness was practically impossible. Finally, in the case of the electrolytically prepared cuprous oxide films we can deposit these on metals other than copper. This would be very difficult by thermal methods.

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#### THE ELECTROLYTIC REDUCTION OF METHYL ETHYL KETONE TO *sec*-BUTYL ALCOHOL AND *n*-BUTANE

By SHERLOCK SWANN, JR., R. W. BENOLIEL, L. R. LYONS AND W. H. PAHL

The electrolytic reduction of methyl ethyl ketone to *sec*-butyl

# Separate Standing Committee on Electroplating Organized By American Society for Testing Materials

## Personnel Announced—Actions on Standards

With the organization by the American Society for Testing Materials of the new Committee B-8 on Electrodeposited Metallic Coatings, effected during A.S.T.M. Committee Week in Washington in March, plans that had been under discussion last year on realignment of the Society's work on electroplating have been put into effect. Probably the first work carried on by the Society in this field was that by Committee A-5 on Corrosion of Iron and Steel. As a corollary of its work on exposure tests of coated iron and steel, the committee developed specifications for coated products. Similarly, Committee B-3 on Corrosion of Non-Ferrous Metals and Alloys reached the point where it believed that the specifications for various coated non-ferrous materials should be prepared and work was initiated with this in view. Committee B-6 on Die-Cast Metals and Alloys was also interested in the plating of die-cast products. In view of the common interest of these several committees, it was felt that the work could be handled more efficiently if it were segregated in a separate committee since the problems incident to the several materials had a great deal in common. After consultation with the various committees, a new committee on electroplating was accordingly authorized by the Society's Executive Committee, the preliminary statement of scope being as follows: The formulation of specifications and methods of test for electrodeposited metallic coatings with the exception of zinc and cadmium applied to steel.

A steering committee consisting of *E. A. Anderson* (chairman), *William Blum*, *W. H. Finkeldey*, *C. H. Sample*, *Sam Tour*, and *J. R. Townsend* assisted the Executive Committee in the selection of the initial personnel. Mr. Anderson was designated temporary chairman and under his guidance organization was effected, with the election of the following committee officers:

*E. M. Baker*, chairman, Prof. of Chemical Engineering, University of Michigan, Ann Arbor, Mich.

*E. A. Anderson*, vice-chairman, New Jersey Zinc Co., Palmerton, Pa.

*Gustaf Soderberg*, secretary, Technical Director, The Udylyte Corp., Detroit, Mich.

A list of the personnel at this time follows:

Aluminum Co. of America, *J. J. Bowman*

American Brass Co., *A. W. Tracy*

American Chain & Cable Co., Inc., *B. Westerman*

American Electroplaters' Society, *A. B. Wilson*

*E. M. Baker*, University of Michigan

Bell Telephone Labs., Inc., *H. G. Arlt*—*C. H. Sample*, Alternate

*William Blum*, National Bureau of Standards

Bridgeport Brass Co., *W. E. Baulieu*

Carnegie-Illinois Steel Corp., *E. S. Taylerson*—*R. A. Dimon*, Alternate

Chase Brass & Copper Co., Inc., *B. H. McGar*

Crane Co., *R. H. Zinkel*

Doehler Die Casting Co., *J. C. Fox*

du Pont de Nemours & Co., Inc., *E. I.*, Grasselli Chemicals Dept.,  
*L. R. Westbrook*

*W. H. Finkeldey*, Singmaster & Breyer

General Electric Co., *W. L. Maucher*

General Motors Corp., *W. M. Phillips*

*A. K. Graham*, Jenkintown, Pa.

*C. E. Heussner*, Chrysler Corp.

*G. B. Hogaboom*, Hanson-Van Winkle-Munning Co.

International Nickel Co., Inc., *R. J. McKay*

*Glen F. Jenks*, U. S. Army, Ordnance Dept.

*Charles A. Marlies*, College of the City of New York

New Jersey Zinc Co., *E. A. Anderson*

Scovill Manufacturing Co., *W. B. Price*

*Erwin Sohn*, Standard Sanitary Manufacturing Co.

*Sam Tour*, Lucius Pitkin, Inc.

Udylyte Corp., *Gustaf Soderberg*

U. S. Navy, Bureau of Ships, Navy Dept., *E. C. Forsyth*—  
*K. D. Williams*, Alternate

U. S. War Dept., Quartermaster Corps, *A. J. Buckley*

Western Electric Co., Inc., *A. M. Wagner*

In connection with certain organization problems and to expedite committee work, an Advisory Committee was set up at the meeting to consist of the newly elected officers and the members of the steering committee.

The following specifications, formerly under the jurisdiction of Committee A-5, have been assigned to this new committee:

Tentative Specifications for Electrodeposited Coatings of Nickel and Chromium on Steel (A.S.T.M. A 166—40 T)

Tentative Methods of Test for Local Thickness of Electrodeposited Coatings on Steel (A.S.T.M. A 219—40 T)

The committee took under immediate consideration standards that have been under development in Committee B-3 and it is proposed to recommend at the A.S.T.M. annual meeting in June proposed new specifications covering:

Electrodeposited Copper-Nickel-Chromium Coatings on Zinc and Zinc Base Alloys

Electrodeposited Nickel-Chromium Coatings on Copper and Copper Base Metals

There was considerable discussion as to the type of subcommittee organization that should be set up. These subcommittees could either be according to type of coating, type of base material, or according to the use of the material. This question will receive further consideration at a future meeting of the committee. Approval of a final statement of the committee's activities will also await action sometime in the future.

# Electrochemical Society Meeting

## Held at Cleveland

The 79th meeting of the Electrochemical Society was held April 16-19 at Cleveland, Ohio.

Professor Victor F. Hess of Fordham University, discoverer of the Cosmic Rays and Nobel Laureate, presented his findings on the electric discharges through the atmosphere as they affect the formation of ozone and radio communication. Another topic of nationwide interest was the electrical properties of selenium and cuprous oxide films used in many thousands of photocells and rectifiers.

Professor G. L. Clark and Dr. P. G. Roach of the University of Illinois reported upon findings of their x-ray studies of these active films, important among which was the fact that impurities in selenium films are not as harmful as heretofore suspected to be.

New applications and new studies of high frequency currents were demonstrated by Dr. E. M. Guyer of the Corning Glass Works. Glass can readily be "welded" by high frequency currents which was heretofore considered impossible. H. B. Osborn, Jr., of the Ohio Crankshaft Company described the application of induction heating to local surface hardening of various steel parts, notably crankshafts. A half dozen papers were devoted to the storage battery and its performance and new methods for its better control. There was a total of twenty-five papers presented covering almost every phase of electrochemistry.

Professor F. C. Mathers of the University of Indiana delivered his presidential address on Thursday evening. The topic of his address was "Adventures in Electroplating."

The thirteenth award of the Weston Fellowship of \$1000 was made to Rodney E. Black of Pawhuska, Okla. Mr. Black is working at the University of Wisconsin on the investigation of the various baths for the plating of molybdenum and tungsten alloys with special interest in the organic amine baths. His work will be continued at the University of Wisconsin under the direction of Professor M. L. Holt.

The Society's Prize to Young Authors was awarded to Dr. Johnstone S. Mackay of Prospect Park, Pa., for the paper entitled, "Photoelectric Cells Sensitive to Long Wave Length Radiation," of which he was co-author. Dr. Mackay is with the Sun Oil Company, Marcus Hook, Pa.

Officers of the Society for 1941 are as follows:

President: Raymond R. Ridgeway, The Norton Co., Chippawa, Ont., Can.

Past President: Professor Frank C. Mathers, Dept. of Chemistry, Indiana University, Bloomington, Ind.

Vice-Presidents: E. M. Baker, G. B. Hogaboom, Sr., M. deK. Thompson. Terms expire 1942. Sherlock Swann, Jr., J. W. Marden, Malcolm Dole. Terms expire 1943.

Treasurer: R. M. Burns, 463 West Street, New York. Term expires 1942.

Secretary: Dr. Colin G. Fink, 3000 Broadway, New York. Term expires 1942.

Abstracts of the technical papers presented at the meeting follow.

### Abstracts of Technical Papers

#### SEMI-CONDUCTOR PHOTOCELLS AND RECTIFIERS

By COLIN G. FINK AND EDWARD ADLER

One of the most interesting products of photoelectric researches during recent years is the semi-conductor cuprous oxide cell. Numerous attempts have been made in the past to satisfactorily interpret the phenomena involved, but so far, due largely to variables not under proper control, experimentally all attempts have failed. One of these variables is the cuprous oxide film. Time and again this has been prepared thermally under apparently identical conditions and yet

the behavior of the oxide and the performance of the cells in which this oxide was incorporated showed wide variations. To date, the best method of producing the photoactive cuprous oxide film or layer has been by thermal oxidation of a copper metal surface. In view of the ease with which cuprous oxide can be produced electrolytically (the red "antifouling" pigment is thus produced commercially) it naturally followed that the electrolytic method with its close control of operating conditions deserved more intensive study in the preparation of light-sensitive layers on copper. However, all electrolytic experiments in the past carried out at Columbia and elsewhere failed to evolve an active cuprous oxide in spite of the wide physical variety of cuprous oxide produced.

Recently a patent\* was published which described deposits com-

\* Stareck, U. S. Pat. 2,081,121 (May 18, 1937).

posed primarily of cuprous oxide. Upon investigation these deposits proved to be photoactive—in other words these were the first electrolytic cuprous oxide deposits which showed appreciable response when exposed to radiation.

One of the fundamental advantages of the electrolytic cuprous oxide film as compared with that produced thermally is the ease with which the thickness of the electrolytic cuprous oxide film or layer can be reproduced and developed to any predetermined desired thickness. Furthermore, films of micron thickness can be produced and reproduced electrochemically but not thermally. This is of particular importance from a theoretical as well as a commercial point of view. Heretofore with the thermally produced oxide the control of film thickness was practically impossible. Finally, in the case of the electrolytically prepared cuprous oxide films we can deposit these on metals other than copper. This would be very difficult by thermal methods.

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By SHERLOCK SWANN, JR., R. W. BENOLIEL, L. R. LYONS AND W. H. PAHL

The electrolytic reduction of methyl ethyl ketone to *sec*-butyl



alcohol and butane in acid solution has been studied at many cathodes. The most active cathodes for *sec*-butyl alcohol formation were lead and zinc. The best yield of *sec*-butyl alcohol was obtained at a zinc cathode. The influence of the crystal structure of the cathode material is discussed.

## STRUCTURE AND GRAIN SIZE OF ELECTRODEPOSITED COPPER

By ALLISON BUTTS AND VITTORIO DE NORA

Variation of grain size with the conditions of electrolysis in deposits from acid copper sulfate solutions was studied quantitatively. Graphs are given showing: (1) the relation between cathode potential and current density at three different acidities and three different temperatures; (2) the relation between grain size and current density at two acidities and three temperatures; (3) the relation between grain size and temperature at different current densities and acidities; (4) the relation between grain size and cathode potential at different current densities, temperatures, and acidities; and (5) the relation between grain size and hardness for different temperatures of deposition. The relation between grain size and acidity was studied for acidities of 18.5 and 50 grams of sulfuric acid per liter. The process of grain formation in electrolysis and the reasons for the relations found are discussed.

## THE IRREVERSIBLE PHENOMENA OF THALLIUM 2. Cathode Potential in $\text{TiSO}_4$ Solution

By I. MILTON LeBARON AND A. R. CHOPPIN

The cathode potential of thallium in  $\text{TiSO}_4$  solutions of various concentrations was determined. The current densities varied from zero to 0.01 amp./cm.<sup>2</sup> The data were applied to the theoretical treatment of Agar and Bowden, and the depth of the diffusion layer calculated. The depth was found to decrease with an increase in current density. The effect of temperature on the cathode potential was determined, and an increase in temperature was found to decrease the overvoltage of the electrode.

## HIGH TEMPERATURE METALLIC RESISTOR FURNACES

By W. KROLL

In the past, high temperature metallic resistor furnaces have generally been of small size and, with the exception of the tungsten lamp factories, their use was limited to laboratory experiments. The new furnaces described are large enough for plant practice. They can be operated continuously. The most suitable type provides for free expansion of the suspended rugged resistor composed of tungsten wires re-enforced by tungsten ribbon. A protective gas within the furnace, such as dry hydrogen, is an important and very essential feature of these tungsten-molybdenum resistor furnaces. A maximum temperature of 2,000° C. is attainable. The method for sintering ceramic cores made of highly refractory oxides is briefly described, and the properties of these cores are discussed.

## THE PHOTOVOLTAIC EFFECT

By COLIN G. FINK AND EDWARD ADLER

In view of the conflicting experimental results obtained in the past with the photovoltaic cell, tests were made under widely varying conditions. A theory is outlined which reconciles the observed experimental phenomena.

## THE CONSTITUTION AND PROPERTIES OF CYANIDE PLATING BATHS

By M. R. THOMPSON

A review is given of some of the properties of the cyanide plating baths of the heavy metals, based upon the probable constitution of the complex metalocyanides which are in solution. Emphasis is laid upon the fact that the metalocyanides constitute a group of coordination compounds. The discussion is designed both to correlate present knowledge and to aid in planning further research.

## INVESTIGATION OF LEAD ANODES IN THE ELECTROLYSIS OF ZINC SULFATE SOLUTIONS

By A. E. KOENIG, J. U. MACEWAN AND E. C. LARSEN

The effects of impurities, either in solution or alloyed with lead,

on anodic reactions in electrolytic zinc deposition were studied. The results show that the lead content of deposited zinc is due chiefly to occluded lead dioxide and the only impurities, of those investigated, that inhibited the formation of lead dioxide are cobalt as sulfate in solution, and silver alloyed with lead as anode. The degree of anodic polarization is a function of the log of the current density. It is indicated that the ratio between the surface of a silver-lead alloy and of a pure lead anode can be determined from the difference in anodic polarizations of these electrodes.

## THE EFFECT OF GAS PRESSURE ON THE PASSIVITY OF IRON

By RICHARD S. CROG AND HERSCHEL HUNT

An attempt was made to determine the effect of decreased pressure on the passivity of iron in chromic acid solutions. Under the conditions of the experiments there was no observed effect. The passivity or activity of the iron was measured by the potential of the iron | chromic acid solution half-cell with a  $\text{Hg} | \text{Hg}_2\text{CrO}_4 | 1.0 \text{ M } \text{H}_2\text{CrO}_4$  electrode as the reference half-cell. Iron was found to be active in chromic acid solutions containing moderate concentrations of halide ions. Iron wires, when heated at red heat in a vacuum (0.01 mm. of Hg), were found to be passive in chromic acid solutions. This agrees with the literature report that heating iron in nitrogen or in a vacuum causes it to become passive. Hence it would seem improbable that an adsorbed film of oxygen could be the cause of the passivity. Some oxide may form when the wire is heated in a vacuum, depending upon the degree of the vacuum; however, no such oxide film should form upon heating in an atmosphere of nitrogen. Therefore, if there were no oxide film on the metal surface before heating it in nitrogen, none should form during the process and the passivity could not be due to an oxide film formed during the heating process. However, this does not preclude the possibility of the formation of such an oxide film after immersion into the chromate solution.

## THE EFFECT OF SILVER (0.05 to 0.15 per cent) ON SOME PROPERTIES AND THE PERFORMANCE OF ANTIMONIAL LEAD STORAGE BATTERY GRIDS

By COLIN G. FINK AND ALBERT J. DORNBLATT

An investigation of the effect of from 0.05 to 0.15% of silver upon the properties and performance, in storage batteries, of lead alloys containing from 4 to 12% of antimony. No previous study of the effect of silver present in the battery grid metal has been published, although some interesting properties of lead anodes containing silver have been known for some time. Sixteen 6-cell storage batteries, representing 16 different grid compositions, were commercially assembled for the tests on battery performance, capacity, retention of charge on open circuit, and battery life. The physical properties of the alloys in the cast and in the heat-treated conditions were determined, as was also the effect upon them of anodic corrosion. The anodic behavior of the alloys was also studied, using the time-potential method.

It was found that about 0.1% of silver added to the antimonial lead inhibits anodic corrosion, increases battery life, and increases the amount of charge retained on open circuit. A method for producing batteries of superior performance by the use of heat-treated grids made of a 4% antimony, 0.1% silver alloy is suggested.

## FORMATION OF ANODIC COATINGS ON ALUMINUM

By JUNIUS D. EDWARDS AND FRED KELLER

The coatings formed on aluminum by anodic oxidation in dilute solutions of sulfuric, oxalic, chromic and boric acids are, as far as can be determined by x-ray and electron diffraction methods, amorphous. They are comprised chiefly of aluminum oxide but also contain substances adsorbed from the electrolyte. Coatings formed in boric acid electrolyte are substantially impervious and non-adsorptive; whereas, those formed in sulfuric, oxalic and chromic acid electrolytes are porous and adsorptive. The porosity in the latter type of coating is attributed to the solvent action of the electrolyte and this porosity is thought to be responsible for the adsorptive characteristics of these coatings. The presence of pores permits the continuous passage of current; consequently, coatings made in these electrolytes can be produced with a substantial thickness. For the electrolytes investigated, the anodic oxidation process is about 100% efficient

as far as the conversion of aluminum to oxide is concerned. As a result of the solvent action of the electrolyte on the oxide, the apparent current efficiency in terms of oxide remaining as coating is shown to be as low as 50% or less. Microscopic examination of especially prepared cross-sections of anodically coated aluminum shows evidence that the oxide has a cellular structure. The fact that the oxide occupies a larger volume than the metal from which it is formed is demonstrated visually. The increase in thickness resulting from the application of an anodic coating must be considered where close fits are required between coated parts.

### INDIUM PLATING

By HENRY B. LINFORD

An indium sulfate plating bath, for the application of smooth matte surface deposits, in thickness of the order of 0.0001" (0.0025 mm.), is described. Operation of this bath over a considerable length of time has shown it to be very stable and constant in performance within the pH range, 2.0 to 2.7. This has been accomplished by the use of a combination of soluble and insoluble anodes for maintaining a constant pH. Conditions are given for obtaining satisfactory plates on many basis metals.

### SILVER PLATING BATHS CONTAINING AMINES

By LYLE I. GILBERTSON AND FRANK C. MATHERS

The hydrocyanides of guanidine and ethylenediamine can be used in aqueous silver plating baths to take the place of sodium and potassium cyanide. These baths are capable of producing plate that is as bright and ductile, and in every way as desirable, as the plate produced from potassium and sodium cyanide baths. With a preliminary strike of silver, in the usual type of potassium cyanide silver strike bath, adherent deposits of silver were produced on steel.

### STUDIES OF ELECTROCHEMICAL POLARIZATION A New Method of Measuring Rates of Polarizing Reactions. A Study of the Diffusion Process.

By ARTHUR E. LORCH

The previously reported studies of the electrochemical polarization of the hydrogen electrode are extended. It is shown that the reaction of oxygen at the electrode is diffusion-controlled even on the weakest platinum and iridium catalysts. A detailed examination is made of the diffusion process.

### DIAGNOSIS OF CANCER BY MEANS OF THE DROPPING MERCURY ELECTRODE

By T. KLATT, H. P. RUSCH, A. DIRKSEN AND V. W. MELOCHE

A study of blood serum reactions was undertaken using the dropping mercury electrode. Experiments on blood sera from cancerous rats, mice and humans gave discordant and overlapping results indicating that the dropping mercury electrode method was not applicable as a specific test for cancer, especially not in the presence of other diseases. However, as a test to distinguish between an advanced carcinoma and a normal, the polarographic method is entirely sensitive and accurate.

### THE POTENTIALS OF IRON-CHROMIUM ALLOYS CONTAINING HYDROGEN

By H. H. UHLIG, N. E. CARR AND P. H. SCHNEIDER

The equilibrium potentials of iron-chromium alloys in oxygen-free 4% NaCl solution are active between 0% and 11.5% Cr showing a gradual trend in a noble direction with increasing chromium concentration. At 11.5% and higher chromium concentrations, the potentials are noble, characteristic of passive metals, with only slight potential change on increasing chromium to 20%. When cathodic hydrogen is diffused from a face of the alloy not in contact with the NaCl solution, the potentials all become more active by several hundredths to several tenths of a volt, the greater change being characteristic of the passive alloys. Relative passivity of the alloys containing interstitial hydrogen persists, the critical chromium concentration for passivity being at 15% instead of 11.5%. The data indicate that recently pickled iron and stainless steels are chemically active, probably because they contain dissolved hydrogen retained

during pickling. The relatively long time to establish the iron or alloy equilibrium potential is presumably governed (1) by the rate at which a metal hydroxide film forms which establishes the ion concentrations and (2) by the rate at which interstitial hydrogen comes into equilibrium with the electrolyte.

The data are explained on the viewpoint supported by additional facts that interstitial hydrogen directly increases the free energy for solution of lattice atoms to ions in aqueous solution.

The potential change of the cell produced by interstitial hydrogen is shown to be delayed by some minutes or hours after starting the cathodic hydrogen discharge, the time depending on the chromium content of the alloy. This delay is a measure of the time for hydrogen diffusion in the alloy. For pickled specimens, the diffusion times are less than for unpickled specimens.

### ELECTRIC CURRENTS IN THE ATMOSPHERE AND THEIR EFFECTS

By VICTOR F. HESS

A survey of all existing vertical electric currents in the atmosphere (conduction current, convection current, lightning and brush discharge) is given and the problem of the maintenance of the electric field in the atmosphere is discussed. It is pointed out that in regions electrically disturbed by lightning and point or glow discharge, considerable amounts of ozone are produced which may account for anomalies found in the ozone content of the lower strata of the atmosphere.

### THE VOLTAGE (DURING DISCHARGE) OF THE SPONGE LEAD PLATE OF THE STORAGE BATTERY

By EUGENE WILLIHNGANZ

Resistance and polarization of the sponge lead plate during discharge of the lead-acid storage battery have been studied. The effects of lead sulfate and weak acid are discussed. It has been found that the principal cause of the voltage loss during discharge is the accumulation of lead ions in solution. This causes polarization.

### THE EFFICIENCY OF A SODIUM CHLORATE CELL WITH ROD CATHODES

By JAMES McLAREN, JACK TURER, F. H. DAVIS, A. L. PITMAN,  
WITH P. H. GROGGINS

The electrochemical oxidation of sodium chloride to sodium chlorate has been studied in cells with graphite anodes. The factors that determine the efficiency and economy of the cell such as pH, temperature, addition agents, attack of graphite, and cell design are discussed. The voltage balance and the operating efficiency for several cell loads are given in order to facilitate the selection of cell characteristics for any situation. Graphite anodes with an apparent density of 1.8 showed greater durability than less dense anodes during a test period of four months. A local-cell mechanism is proposed for the catalytic effects observed in cathodic reduction. A cell designed with rod cathodes has a consumption of energy and graphite that is lower than in previous cells.

### HIGH FREQUENCY ELECTRIC GLASS WELDING

A Contribution of Electrothermics to the Glass Art

By E. M. GUYER

There has been an ever increasing demand on the part of the electrical industry for special glasses, such as would stand higher temperatures. To the glass worker this has meant the faster melting of larger masses of harder glasses. There are serious limitations in melting glass by gas and fire. Faster melting of larger masses of harder glass led to electrical melting. High frequency electric glass welding has been successfully applied to the manufacture of new glassware and to the repair of glass articles broken in service. Numerous cases of electric glass welding are described. The outstanding advantages over the older art of gas heating are: more exact control of glass temperature and of time rate of change of heating rate; sharp definition of heating zone or temperature control in space.

(Concluded on page 257)

# Fundamentals of Science Relating to Electroplating

## Chapter IX. Electrochemical Terms are Reviewed

The discussion of chemical reactions in the preceding chapter brings to a close for the present the consideration of inorganic chemistry as such. Logically, the basic principles of one other subject, namely electricity, should be at least outlined before electrochemistry itself is considered and the former will therefore be the subject matter of the next chapter. Before proceeding to it, however, it may be well to briefly review, in a more popular than technical manner, the terms and expressions which have been introduced thus far.

We deal with *matter*, which is anything that occupies space. All matter is made up of elementary substances, *elements*, either alone or in combination. Today, only 92 different elements are recognized, and they can be arranged in a *periodic table* or *chart* so that their physical and chemical properties fall into groups and vary in quite an orderly manner. A combination of elements, which is uniform in composition throughout and which always contains the elements in a definite proportion by weight, is called a *compound*. The smallest particle of an element which can react chemically in the usual sense is called an *atom*. The smallest particle of a compound which can exist and still retain the properties of that compound is called a *molecule*. A molecule is therefore made up of atoms. Finally, at the bottom of the scale, we find that the atom itself is made up of a *nucleus*, positively charged with electricity, around which revolve enough negatively charged units, called *electrons*, to make the normal atom electrically neutral.

An atom of the element oxygen has been given the relative weight of 16.000 units. All the other atoms of elements have definite weights relative to oxygen, called *atomic weights*. The sum of the atomic weights of the elements in a molecule of a compound is called the *molecular weight*. In any particular chemical reaction, definite and constant ratios of molecules or atoms react. Atomic and molecular weights enable us to calculate how much of each substance is concerned in any reaction, how much is formed, and what percentage of the whole compound is each constituent element.

A few other of the important terms that have been discussed are:

**Ion:** When an atom of an element, which is electrically neutral, loses or gains electrons, it becomes positively or negatively charged, respectively, and the charged atom is called an ion.

**Radical:** When certain elements very frequently occur chemically combined in a definite ratio by weight, resulting in a combination which has characteristic chemical properties of its own, that combination is called a radical.

**Valence** is the chemical combining power of an element or of a radical and may have values from 1 through 7. An element may have either positive valence (meaning that it forms ions with that valence number of positive charges) or negative valence, with a corresponding meaning, but in any neutral molecule of a compound, the total positive valence must of course equal the total negative valence.

Some of the types of substances with which we are concerned are as follows:

**Metals**, which are substances having certain characteristic physical, mechanical, chemical, electrical, thermal and magnetic properties. Among other things, they are always crystalline, have relatively high electrical and thermal conductivity, develop a difference in electrical potential (a voltage) when in contact with one another, have a positive valence, etc.

**Acids**, which are substances forming hydrogen ions when dissolved in water. The concentration of hydrogen ions present at any time is the pH of the solution.

**Bases**, which are substances forming the hydroxyl ions (OH)- when dissolved in water.

**Salts**, which are substances formed from the combination of acids with bases.

Those acids and bases which *ionize* (form ions) to a great extent are called strong acids and bases. The breaking-down of a substance into its constituent ions or atoms is also called *dissociation*.

Some of the various types of chemical reactions possible which were discussed above are *oxidation*, which involves an increase in valence of an element, *reduction*, which involves a decrease in valence, *hydrolysis*, which means reaction of a substance with water, and *displacement*, which refers to the ability of one metal to "plate-out" or displace another metal from solution, while it itself goes into solution. The *electromotive series of metals* lists the metal elements in the order in which they would displace one another from solutions containing a "normal" concentration of the ions of the elements concerned.

It was pointed out in an earlier chapter that electricity can be conducted in two different ways (or by a combination of the two). In one case, which may be called metallic conduction, the flow of electricity is due to the drift of the free electrons which exist in the metal. In the other case, typified by conduction through a plating solution, the flow of electricity is due to the directed motion of the ions in the solution. In either case, certain fundamental laws apply, which hold in all our electroplating processes, except that secondary effects sometimes complicate the picture.

At the beginning, certain terms and definitions must be made clear. The electroplating industry especially is guilty of rather loose usage of various expressions: current is miscalled power, current density is miscalled current, polarization is merely a convenient word to be used when all other words fail, etc.

First of all, the unit of *quantity* of electricity is the *coulomb*, in honor of the Frenchman, C. A. Coulomb. It may be defined as the quantity of electricity which will deposit from a silver nitrate solution, under specified conditions, 0.001118 grams of silver. The word current does not refer to quantity; it refers to rate of flow. When electricity flows at such a rate that one coulomb of it passes a given point every second, there is said to be a current (a "stream") of electricity of one *ampere* flowing. One ampere is thus equivalent to one coulomb per second or

$$\text{Amperes} = \frac{\text{Coulombs}}{\text{Time in seconds}}$$

$$\text{Coulombs} = \text{Amperes} \times \text{No. of seconds during which the current flows.}$$

Coulombs and ampere-seconds are thus identical.

One thousand coulombs, one thousand ampere-seconds, 100 amperes flowing for 10 seconds, 5 amperes flowing for 200 seconds—they are all equivalent; in each case  $1000 \times .001118 = 1.118$  g. of silver would be deposited from the proper bath. Note that the weight of deposit obtained depends only on the number of coulombs used (at 100% plating efficiency) and not on the current alone nor on any other single factor.

There is always some resistance to the passage of current, just as there is resistance in a pipe to the flow of water. Electrical resistance is measured in *ohms*, after the German, G. S. Ohm. One ohm is defined as the resistance to the passage of electricity offered at 0° C by a column of mercury 106.3 cm. long and with a cross-section of 1 sq. mm. The resistance of a conductor depends on its dimensions, the nature of the material, and the temperature. In the case of solutions, the "nature" of the material includes not only "what" is in the solution, but also "how much" there is of it. The shorter the path through which the current must pass and the greater the cross-section of this path, the lower is the resistance. Increasing the temperature of a metallic conductor generally increases the resistance, while the opposite is true in the case of solutions.

Water will not continue to flow through a pipe unless there is a



"head" somewhere or a driving force or pressure. The pressure needed to maintain the flow of electricity is called an *electromotive force*, sometimes called *potential difference* and *voltage*, the latter because this force is measured in terms of volts, in honor of the Italian Count Signor Volta. One *volt* is defined as that pressure or difference in potential which is required to maintain a current of 1 ampere flowing through a resistance of 1 ohm.

The relation between the three important units—volt, ampere, and ohm—is called Ohm's law and states that the electromotive force (always abbreviated E. M. F.) is equal to the product of the current it causes to flow times the resistance through which it flows or

$$\text{E. M. F.} = \text{Current} \times \text{Resistance}$$

$$\text{Volts} = \text{Amperes} \times \text{Ohms}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$\text{Ohms} = \frac{\text{Volts}}{\text{Amperes}}$$

For example, if a six volt generator is short-circuited across a resistance coil of 0.1 ohm, the current that will flow will be

$$I = \frac{E}{R} = \frac{6}{0.1} = 60 \text{ amperes.}$$

If a current of 50 amperes flows through a bus bar having a resistance of 0.01 ohm, the voltage from end to end of the bus bar (i.e. the voltage drop) will be  $50 \times 0.01 = 0.5$  volt.

Two other terms need defining at this time. Strangely enough, perhaps, one of them is "work." Electrical *work* is done in electroplating, and it is measured in *joules* (pronounced jow-els). One joule is the work done due to the action of 1 ampere flowing for 1 second under a potential difference of 1 volt. The *rate* at which work is done is called *power*, often measured in *watts*. One watt is equal to 1 joule per second, and is also equal to 1 volt multiplied by 1 ampere, called a volt-ampere. The word power should therefore never be used in plating to indicate current. Two amperes at 2 volts is equivalent to a power of 4 watts. Four amperes at 1 volt is equivalent to the same power of 4 watts, although the current has been doubled. The doubled current (at 100% plating efficiency) means a doubled weight of deposit in the same plating time, even though the power is the same in each case.

One horsepower is equivalent to 746 watts. Suppose that a generator were being bought to deliver 100 amperes at 6 volts. The power required of the generator would be  $100 \times 6 = 600$  watts. A 1 horsepower motor (equivalent to 746 watts) would therefore be ample to drive it.

When electricity flows through a conductor, heat is generated. The power lost (since the heating is usually not desired) is equal to the resistance of the conductor multiplied by the square of the current flowing through it. Thus if the current is doubled, the heating effect is 4 times as great. This heating effect, in the case of a metallic conductor like a bus bar, especially if the cross-section is too small, increases the resistance of the conductor, causing either a voltage rise or a current drop. All these effects can be foretold and computed from the principles laid down above.

(To be continued)

## ELECTROCHEMICAL SOCIETY MEETING HELD AT CLEVELAND

(Concluded from page 255)

### A BRIDGE FOR MEASURING LEAD STORAGE BATTERY RESISTANCE

By EUGENE WILLIHNGANZ

An alternating current Wheatstone bridge has been designed and built which can be used to measure battery resistance of the order of 0.004 ohm with an estimated accuracy of 2%.

### THE DEPOSITION OF ANTIMONY ON NEGATIVE BATTERY PLATES

By J. W. R. BYFIELD

The work of other investigators is confirmed by tests carried out on a comprehensive scale. These tests show that the presence of antimony in the active material of the negative battery plates of the starting and lighting type is far in excess of any quantity of

antimony which could possibly diffuse from the negative grid under ordinary circumstances. The antimony deposit has been found to be diffused throughout the pores of the plates as well as appearing on the surface of the plates where it is or can be rendered plainly visible. The deposit has a distinct, characteristic appearance which makes it easily recognizable. The deposit is present on all negative plates of the above "Starting, Lighting, Ignition" battery type which have been in service for more than a few months or, at most, a year.

## SURFACE HARDENING BY INDUCTION

By H. B. OSBORN, JR.

High frequency induction heating is ideal for localized surface hardening of crankshafts and a wide variety of machine parts. There is practically no distortion nor scale formation. Time cycles of only a few seconds are maintained by automatic regulation. The usual and expensive pretreatment such as copper plating and carburizing are eliminated. The transformation of pearlite into austenite is extremely rapid. A fine nodular and more homogeneous martensite results from induction hardening. This fine structure must have for its origin an austenite which is the result of a more thorough carbide diffusion than is obtained with thermal heating. Details of equipment and operation are included.

## AN X-RAY STUDY OF THE STRUCTURE OF RECTIFYING SELENIUM FILMS

By G. L. CLARK AND P. G. ROACH

Methods are described for the preparation of thin films of selenium with suitable metallic backing electrodes and counter electrodes, which serve as rectifying films, the measurement of resistances of these films and x-ray diffraction analyses of structure. The change from amorphous to hexagonal crystalline form is effected by heating at 200° C., causing a rapid decrease in electrical resistance and increasing rectifying power with increase in crystal size. The effects of oxide and selenide formation at the interfaces are studied both by the measurement of electrical resistances and by x-ray and electron diffraction analysis of interfacial surfaces.

From results of experiments involving addition of certain substances to selenium, the purification of commercial selenium, spectrographic studies and interchange of selenium and backing electrodes, from commercial and experimental rectifiers, the conclusion is made that impurities are not highly influential on ultimate resistances and rectifying properties. Evidence obtained from heat treatments in different atmospheres, polishing of selenium film surfaces, crystallization of amorphous selenium by organic reagents, and other experiments show that the rectifying action is at the selenium counter-electrode interface. Polishing the surface results in decrease in particle size, with no evidence of the formation of an amorphous phase and a very large increase in rectifying properties.

Phenylhydrazine and quinoline change amorphous selenium to the hexagonal form. The former gives rise to crystalline films in which crystals have preferred orientation, with no enhancement of rectifying properties, while the latter gives a randomly oriented film, with enhanced rectifying properties. It is not possible to convert monoclinic selenium, formed by the action of ethyl alcohol on amorphous selenium, into the hexagonal form by use of phenylhydrazine. Brief consideration is given, incidentally, to the theories of rectifier action.

## FORMATION OF LEAD MONOXIDE AS A CABLE SHEATH CORROSION PRODUCT

By EDGAR F. WOLF AND CHARLES F. BONILLA

Corrosion of lead cable sheathing is of considerable importance to the electric and communication industries. When corrosion is encountered in an underground sheath, it may be of assistance, in combating the phenomenon, to know those limiting conditions under which the particular corrosion product can be formed. The authors studied the conditions of voltage and electrolyte composition under which the tetragonal or red modification of lead monoxide is formed at room temperature. The twenty-six solutes investigated are grouped into five classes according to the nature of the corrosion. Low salt concentration, voltage below 1.0 volt, and low solubility of the lead salt of the corroding anion are found to favor red lead monoxide formation.

# ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

## Cleaning Metal Strip

*U. S. Patent No. 2,234,593.* J. T. Ferm & E. W. Hoppe, assignors to Pittsburgh Crucible Steel Co., March 11, 1941. An apparatus for cleaning metal strip with a plurality of baths and roll feed conveyor.

## Pickling Metal Strip

*U. S. Patent No. 2,234,815.* F. J. Wood, assignor to Goodman Mfg. Co., Mar. 11, 1941. A pickling tank equipped with nozzles to spray the pickling solution under pressure on the strip.

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## Electroformed Screen

*U. S. Patent No. 2,226,381.* E. O. Norris, assignor to Edward O. Norris, Inc., December 24, 1940. A method of forming a fine mesh screen, which comprises the steps of electrodepositing metal on a metallic matrix dotted with resist areas, arresting the electrodeposition of metal before the apertures in the deposited sheet at resist areas have been materially reduced, stripping the deposited sheet from the matrix, electrodepositing a coating of metal on the deposited sheet, arresting the deposition of the coating metal before the apertures in the sheet have been closed over, and etching out the apertures to desired size by maintaining a head of etching liquid on the coated sheet and causing the liquid to stream through the apertures therein, the metal of the original deposit being of such nature as to offer a higher resistance to said etching liquid than does coating metal.

## Buffing Wheel

*U. S. Patent 2,226,625.* L. W. MacFarland and S. Krugloff, assigned by Krugloff to MacFarland, December 31, 1940. In a buffing wheel, a plurality of folded segments disposed in an endless series forming an annular buffing element with a substantial portion of the fold in each segment extending along the inner periphery of said annular element and another substantial portion of said fold extending outwardly from said inner periphery.

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## Gold Plating Ferrous Alloys

*U. S. Patent 2,227,454.* J. B. Kushner, assignor to B. Robinson, January 7, 1941. The method of electroplating gold on ferrous metals consisting in cleaning the article to be plated in an alkaline bath, removing the oxide in a solution of hydrofluosilicic acid or a mild ionized acid bath, at the same time producing a mild etch, rinsing and plating in a bath containing potassium cyanide, potassium carbonate, potassium gold cyanide and a reagent consisting of ammonium benzoate and sodium formate to suppress the ionization of the gold so as to cause the gold to be deposited in a fine adherent state and to cause the lowering of the attacking effect of the free cyanide on the article by depressing the ionization to permit the gold to be deposited on the surface of the article before a tarnish film can form.

Example: *Pickle*—

Conc. hydrofluosilicic acid ..... 50-100 parts by volume  
35% hydrofluoric acid ..... 5 " " "  
Distilled water ..... 25-50 " " "

Immerse for 30 seconds to one minute. Fluoboric acid or acids of the combination of the silicon earth group and fluorine may be substituted for the hydrofluosilicic acid.

Example: *Plating Solution*—

Potassium cyanide ..... 10 grams/liter  
Potassium carbonate ..... 8 " "  
Potassium gold cyanide ..... 2 " "  
Ammonium benzoate ..... 0.25 " "  
Sodium formate ..... 0.25 " "

## Iron Plating Shafting

*U. S. Patent 2,229,077.* W. H. Hammond, E. I. Adolphson and W. Y. Young (Hawaii), January 21, 1941. A method of building up worn shafts comprising the steps of cutting down to an even surface of good metal, applying a rusting solution of 1 part of hydrochloric acid, 1 part ethanol and 8 parts water

and allowing it to remain overnight to provide a slightly matted surface, pickling in approximate 30% sulfuric acid as cathode at a minimum c.d. of about 600 amp/sq. ft. for 24 minutes, scratch brushing to remove smut, rinsing and plating in a bath of ferrous sulfate and ferrous ammonium sulfate with a c.d. of about 80 amp/sq. ft. and a temperature of not less than 150° F., adding ferrous sulfate and ammonia to maintain the solution, stirring by continuous gas flow, maintaining the pH at above 6 and not over 6.4 by increasing the rate of ammonia addition to increase the pH and increasing the gas flow to decrease the pH.

## Bright Nickel

*U. S. Patent 2,228,991.* M. L. Freed, assignor to The Seymour Mfg. Co., January 14, 1941. A brightener for nickel solutions consisting of ions of cobalt and at least one other metal consisting of cadmium, zinc and mercury in the proportions approximating about 7.25 parts of cobalt to about 1 part of the single or combined other metals.

Example of *Brightener*:

Cobalt chloride, crystal	14%
Cadmium chloride, crystal	1%
Ammonium chloride	3%
Nickel chloride	7%
Sodium sulfate, anhydrous	3%
Sulfuric acid	2%
Water	70%

Example of *Plating Solution*:

Double nickel salts	12 oz./gal
Single nickel salts	4 "
Boric acid	3 "
Ammonium chloride	4.5 "
Sodium chloride	0.8 "
Brightener	0.4 "

pH = 5.5

Temperature = 70° F.

C.D. = up to 48 amp./sq. ft.

Deposit has a bluish cast.

## Electroformed Screen

*U. S. Patent No. 2,230,868.* T. C. Kuhlman, Feb. 4, 1941. The process of forming articles consisting of sheets of uniformly reticulated metal which comprises photographing and then etching a reticulated design upon a metal foundation composed of copper receptive to plating in a standard copper sulfate solution, electroplating the portions of said foundation, exclusive of the elements of said design, with a metal normally inert to plating in a standard copper sulfate solution, removing the etching ground from the raised portions, chromium plating the resulting matrix, electrodepositing a copper film from said solution on the raised elements of the design and stripping the resultant reticulated metal sheets from the matrix.

## Immersion Lead Plating

*U. S. Patent No. 2,230,602. J. D. Sullivan, assignor to Battelle Memorial Inst., Feb. 4, 1941.* The method of forming a lead coating on the surface of a metal or alloy which comprises contacting said surface with an alkaline aqueous solution containing an ionizable lead compound and at least 5 g./l. of a compound selected from the class consisting of alkali metal and alkaline earth cyanides, for a sufficient time to form a permanent lead coating of substantial thickness on said surface without aid of externally applied electric potential, said metal or alloy being from that group of metals which when immersed in said solution have higher electrode potentials than lead. The solution may also contain a substance selected from the class consisting of alkali hydroxides, oxalates, tartrates, silicates and citrates. The patent claims a lead content of from 0.1-10 g./l.

*Example:* For iron or steel.

1. Lead nitrate	6	g./l.
Sodium cyanide	100	"
Temp. 180°-200° F.		
2. Lead monoxide	5	"
Caustic soda	100	"
Sodium cyanide	10	"
Nekal BX	2.5	"
Temp. 180°-200° F.		
3. Lead monoxide	1.5	"
Caustic soda	100	"
Sodium cyanide	50	"
Nekal BX	0.05	"
Room temperature.		

*Example:* For copper or zinc.

1. Lead monoxide	3	"
Caustic soda	100	"
Sodium cyanide	25	"
Room temperature.		

## Zinc Plated Article

*U. S. Patent No. 2,231,967. U. C. Tainton, Feb. 18, 1941.* A ferrous article having an adherent electrozinc coating of substantial thickness, said coating being coarsely crystalline with the crystals substantially continuous from the ferrous surface to the outside surface of the coating, the axes of crystal growth being approximately normal to the ferrous surface, and the outside position of the crystal growth being distorted to provide a smooth surface.

The crystalline characteristics are claimed to give a very high degree of ductility and the coating lends itself to high speed plating. The current must not be interrupted to avoid laminated deposits. The electrolyte is zinc sulfate with a high concentration of sulfuric acid (20-30% free  $H_2SO_4$ ) plus the addition of small amount of inorganic colloids such as silica and alumina.

## Paint Spray Booth

*U. S. Patent No. 2,232,561. R. M. Richards, assignor to Industrial Sheet Metal Works, Inc., Feb. 18, 1941.* A wet spray booth of improved design.

## Buffing Wheel

*U. S. Patent 2,226,624 L. W. MacFarland and S. Krugloff, assigned by Krugloff to MacFarland, December 31, 1940.* A sectional buffing wheel of novel construction.

## Anodizing Aluminum & Its Alloys

*U. S. Patent No. 2,231,086. A. Müller & J. Korpium (Germany), assignors to Sherka Chemical Co., Inc., Feb. 11, 1941.* A bath containing compounds of heavy metals having more than one stage of oxidation with simple acids, said compounds being soluble and stable in said acid bath and not being decomposed under the influence of the electric current, said heavy metals being taken from the class consisting of manganese, cobalt, nickel, molybdenum, chromium and tungsten, and the acids from the group consisting of sulfuric acid, phosphoric acid, oxalic acid and hydrogen peroxide.

*Example:*

Tungstic acid	20	grams
Water	30	cc.

Add this mixture to a solution of 300 grams of sodium sulfate and 420 grams of citric acid in 1 liter of water. Operate at 20-30° C., alternating current, 15-25 volts. Time about 30 minutes.

Instead of the 300 grams of sodium sulfate, 50 grams of sulfuric acid may be used, the film forming in 60 minutes at room temp. and with a voltage of 15-20 volts.

*Example:*

Oxalic acid	60	g./l.
Molybdo-oxalic acid	40	"
Room temp. 21 volts. Alternating current.		

*Example:*

Sulfuric acid	50	g./l.
Crystal cobalt sulfate	20	"
Room temp. 21 volts. Alternating current.		

## Corrosion Prevention of Aluminum

*U. S. Patent No. 2,231,373. M. Schenk (Switzerland), assignor to Emetal Electrochemical Corp., Feb. 11, 1941.* A process for producing integral coatings containing titanium dioxide on articles of aluminum or its alloys, which comprises immersing said articles in an aqueous acid bath of pH 1-3.5 approximately, containing titanium cations and containing anions, said titanium cations being selected from the group consisting of those containing trivalent and tetravalent titanium, said anions consisting of those which are oxygen containing and will promote the formation of hard, adherent, opaque and enamel-like films on said articles and comprising those selected from the group consisting of the anions of phosphoric acid, chromic acid, arsenic acid and boric acid, and passing electric current through said articles as the anode.

*Example:*

Titanyl potassium oxalate	50	kg.
$TiO(KC_2O_4)_2 \cdot 2H_2O$		
Citric acid	15	"
Glucose	20	"
Phosphoric acid	6	"
Water	1,000	"

110 volts alternating current. 75° C. 5-6 amps./sq. dm.

Time = until 2.5 ampere hours per square decimeter have passed.

## Electroplating Apparatus

*U. S. Patent 2,229,423 J. L. Schueler, J. L. Bray and G. Holdeman, assignors to Purdue Research Foundation, January 21, 1941.* A machine for electroplating wire and the like.

## Plating on Aluminum

*U. S. Patent No. 2,233,410. J. Frasch (France), assignor to Societe de Produits Chimiques des Terres Rares (France), March 4, 1941.* A process of nickel plating aluminum which comprises first degreasing as cathode in an electrolyte which contains several per cent of an alkali and several per cent of cyanide and several per cent of zinc sulfate or other metal more electropositive than nickel and less electropositive than aluminum and thereafter electroplating nickel thereupon using an aqueous solution of polyamino-nickelo-sulfate, ammonium acetate and magnesium sulfate. Hexa-amino-nickelo-sulfate may be used instead of polyamino-nickelo-sulfate.

*Example:* Degreasing solution.

1. Manganese sulfate	3-5%
Sodium cyanide	2-6%
Ammonia	2-8%
Gelatin	0.5-1%
Cathode at less than 2 volts, preferably 1-1.5 volts.	
2. Zinc sulfate	4-6%
Sodium cyanide	4-8%
Potassium hydroxide	2-8%
Dextrin	0.5-1%
Cathodic at a minimum of 0.5-1 volt.	

*Example:* Plating Solution.

Hexa-amino-nickelo-sulfate	15-45%
Ammonium acetate	1-5%
Magnesium sulfate	10-15%
C.D. 0.25-6 amps./sq. dm.; 2-4 volts; room temp. or hot.	

## Tin Recovery

*U. S. Patent 2,229,073 W. C. Gregory, January 21, 1941.* The method of recovering tin from used tin cans which includes the steps of: dissolving the tin in an alkaline electrolyte and converting the materials of low electrical conductivity associated with such cans to soluble soaps by washing the cans with said electrolyte, converting the soluble soaps to insoluble soaps by adding sodium chloride and depositing the tin electrolytically from said electrolyte upon a cathode while mechanically sweeping the cathode with such insoluble soaps.

## Pickling Inhibitor

*U. S. Patent 2,227,804 E. C. Britton and F. N. Alquist, assignors to The Dow Chemical Co., January 7, 1941.* An alcoholic solution of substantially copper-free mono-aminated phenyl-diphenyl oxide composition produced by reacting ammonia with monochlorinated phenyl-diphenyl oxide, said composition being an oily liquid distilling between about 155° C. and about 210° C. at 6 mm. pressure and having a specific gravity of about 1.06-1.08 at 150° C., a chlorine content of about 0.0-3.5% and a nitrogen content of about 2.9-7.6%.

## Corrosion Prevention

*U. S. Patent 2,227,945 H. R. Neilson, January 7, 1941.* A composition for causing formation of a water insoluble coating on ferrous metals, comprising water, phosphoric acid and sodium secondary alcohol sulfate which is left to act on the surface until dry. The coated surface is then treated with dilute ammonia solution (0.2-1% for example).



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Deposit has a bluish cast.

## Electroformed Screen

*U. S. Patent No. 2,230,868.* T. C. Kuhlman, Feb. 4, 1941. The process of forming articles consisting of sheets of uniformly reticulated metal which comprises photographing and then etching a reticulated design upon a metal foundation composed of copper receptive to plating in a standard copper sulfate solution, electroplating the portions of said foundation, exclusive of the elements of said design, with a metal normally inert to plating in a standard copper sulfate solution, removing the etching ground from the raised portions, chromium plating the resulting matrix, electrodepositing a copper film from said solution on the raised elements of the design and stripping the resultant reticulated metal sheets from the matrix.

### Immersion Lead Plating

U. S. Patent No. 2,230,602. J. D. Sullivan, assignor to Battelle Memorial Inst., Feb. 4, 1941. The method of forming a lead coating on the surface of a metal or alloy which comprises contacting said surface with an alkaline aqueous solution containing an ionizable lead compound and at least 5 g./l. of a compound selected from the class consisting of alkali metal and alkaline earth cyanides, for a sufficient time to form a permanent lead coating of substantial thickness on said surface without aid of externally applied electric potential, said metal or alloy being from that group of metals which when immersed in said solution have higher electrode potentials than lead. The solution may also contain a substance selected from the class consisting of alkali hydroxides, oxalates, tartrates, silicates and citrates. The patent claims a lead content of from 0.1-10 g./l.

Example: For iron or steel.

- |                    |      |       |
|--------------------|------|-------|
| 1. Lead nitrate    | 6    | g./l. |
| Sodium cyanide     | 100  | "     |
| Temp. 180°-200° F. |      |       |
| 2. Lead monoxide   | 5    | "     |
| Caustic soda       | 100  | "     |
| Sodium cyanide     | 10   | "     |
| Nekal BX           | 2.5  | "     |
| Temp. 180°-200° F. |      |       |
| 3. Lead monoxide   | 1.5  | "     |
| Caustic soda       | 100  | "     |
| Sodium cyanide     | 50   | "     |
| Nekal BX           | 0.05 | "     |
| Room temperature.  |      |       |

Example: For copper or zinc.

- |                   |     |   |
|-------------------|-----|---|
| 1. Lead monoxide  | 3   | " |
| Caustic soda      | 100 | " |
| Sodium cyanide    | 25  | " |
| Room temperature. |     |   |

### Zinc Plated Article

U. S. Patent No. 2,231,967. U. C. Tainton, Feb. 18, 1941. A ferrous article having an adherent electrozinc coating of substantial thickness, said coating being coarsely crystalline with the crystals substantially continuous from the ferrous surface to the outside surface of the coating, the axes of crystal growth being approximately normal to the ferrous surface, and the outside position of the crystal growth being distorted to provide a smooth surface.

The crystalline characteristics are claimed to give a very high degree of ductility and the coating lends itself to high speed plating. The current must not be interrupted to avoid laminated deposits. The electrolyte is zinc sulfate with a high concentration of sulfuric acid (20-30% free  $H_2SO_4$ ) plus the addition of small amount of inorganic colloids such as silica and alumina.

### Paint Spray Booth

U. S. Patent No. 2,232,561. R. M. Richards, assignor to Industrial Sheet Metal Works, Inc., Feb. 18, 1941. A wet spray booth of improved design.

### Buffing Wheel

U. S. Patent 2,226,624 L. W. MacFarland and S. Krugloff, assigned by Krugloff to MacFarland, December 31, 1940. A sectional buffing wheel of novel construction.

### Anodizing Aluminum & Its Alloys

U. S. Patent No. 2,231,086. A. Müller & J. Korpium (Germany), assignors to Sherka Chemical Co., Inc., Feb. 11, 1941. A bath containing compounds of heavy metals having more than one stage of oxidation with simple acids, said compounds being soluble and stable in said acid bath and not being decomposed under the influence of the electric current, said heavy metals being taken from the class consisting of manganese, cobalt, nickel, molybdenum, chromium and tungsten, and the acids from the group consisting of sulfuric acid, phosphoric acid, oxalic acid and hydrogen peroxide.

Example:

- |               |    |       |
|---------------|----|-------|
| Tungstic acid | 20 | grams |
| Water         | 30 | cc.   |

Add this mixture to a solution of 300 grams of sodium sulfate and 420 grams of citric acid in 1 liter of water. Operate at 20-30° C., alternating current, 15-25 volts. Time about 30 minutes.

Instead of the 300 grams of sodium sulfate, 50 grams of sulfuric acid may be used, the film forming in 60 minutes at room temp. and with a voltage of 15-20 volts.

Example:

- |   |    |       |
|---|----|-------|
| Oxalic acid                               | 60 | g./l. |
| Molybdo-oxalic acid                       | 40 | "     |
| Room temp. 21 volts. Alternating current. |    |       |

Example:

- |   |    |       |
|---|----|-------|
| Sulfuric acid                             | 50 | g./l. |
| Crystal cobalt sulfate                    | 20 | "     |
| Room temp. 21 volts. Alternating current. |    |       |

### Corrosion Prevention of Aluminum

U. S. Patent No. 2,231,373. M. Schenk (Switzerland), assignor to Emetal Electrochemical Corp., Feb. 11, 1941. A process for producing integral coatings containing titanium dioxide on articles of aluminum or its alloys, which comprises immersing said articles in an aqueous acid bath of pH 1-3.5 approximately, containing titanium cations and containing anions, said titanium cations being selected from the group consisting of those containing trivalent and tetravalent titanium, said anions consisting of those which are oxygen containing and will promote the formation of hard, adherent, opaque and enamel-like films on said articles and comprising those selected from the group consisting of the anions of phosphoric acid, chromic acid, arsenic acid and boric acid, and passing electric current through said articles as the anode.

Example:

- |   |       |     |
|---|-------|-----|
| Titanyl potassium oxalate                               | 50    | kg. |
| $TiO(KC_2O_4)_2 \cdot 2H_2O$                            |       |     |
| Citric acid   | 15    | "   |
| Glucose   | 20    | "   |
| Phosphoric acid   | 6     | "   |
| Water   | 1,000 | "   |
| 110 volts alternating current. 75° C. 5-6 amps./sq. dm. |       |     |

Time = until 2.5 ampere hours per square decimeter have passed.

### Electroplating Apparatus

U. S. Patent 2,229,423 J. L. Schueler, J. L. Bray and G. Holdeman, assignors to Purdue Research Foundation, January 21, 1941. A machine for electroplating wire and the like.

### Plating on Aluminum

U. S. Patent No. 2,233,410. J. Frasch (France), assignor to Societe de Produits Chimiques des Terres Rares (France), March 4, 1941. A process of nickel plating aluminum which comprises first degreasing as cathode in an electrolyte which contains several per cent of an alkali and several per cent of cyanide and several per cent of zinc sulfate or other metal more electropositive than nickel and less electropositive than aluminum and thereafter electroplating nickel thereupon using an aqueous solution of polyamino-nickelo-sulfate, ammonium acetate and magnesium sulfate. Hexa-amino-nickelo-sulfate may be used instead of polyamino-nickelo-sulfate.

Example: Degreasing solution.

- |   |        |
|---|--------|
| 1. Manganese sulfate                                  | 3-5%   |
| Sodium cyanide  | 2-6%   |
| Ammonia   | 2-8%   |
| Gelatin   | 0.5-1% |
| Cathode at less than 2 volts, preferably 1-1.5 volts. |        |
| 2. Zinc sulfate                                       | 4-6%   |
| Sodium cyanide  | 4-8%   |
| Potassium hydroxide                                   | 2-8%   |
| Dextrin   | 0.5-1% |
| Cathodic at a minimum of 0.5-1 volt.                  |        |

Example: Plating Solution.

- |  |        |
|--|--------|
| Hexa-amino-nickelo-sulfate                               | 15-45% |
| Ammonium acetate   | 1-5%   |
| Magnesium sulfate  | 10-15% |
| C.D. 0.25-6 amps./sq. dm.; 2-4 volts; room temp. or hot. |        |

### Tin Recovery

U. S. Patent 2,229,073 W. C. Gregory, January 21, 1941. The method of recovering tin from used tin cans which includes the steps of: dissolving the tin in an alkaline electrolyte and converting the materials of low electrical conductivity associated with such cans to soluble soaps by washing the cans with said electrolyte, converting the soluble soaps to insoluble soaps by adding sodium chloride and depositing the tin electrolytically from said electrolyte upon a cathode while mechanically sweeping the cathode with such insoluble soaps.

### Pickling Inhibitor

U. S. Patent 2,227,804 E. C. Britton and F. N. Alquist, assignors to The Dow Chemical Co., January 7, 1941. An alcoholic solution of substantially copper-free mono-aminated phenyl-diphenyl oxide composition produced by reacting ammonia with mono-chlorinated phenyl-diphenyl oxide, said composition being an oily liquid distilling between about 155° C. and about 210° C. at 6 mm. pressure and having a specific gravity of about 1.06-1.08 at 150° C., a chlorine content of about 0.0-3.5% and a nitrogen content of about 2.9-7.6%.

### Corrosion Prevention

U. S. Patent 2,227,945 H. R. Neilson, January 7, 1941. A composition for causing formation of a water insoluble coating on ferrous metals, comprising water, phosphoric acid and sodium secondary alcohol sulfate which is left to act on the surface until dry. The coated surface is then treated with dilute ammonia solution (0.2-1% for example).

# NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

## Chromium Plating with Selenium Rectifier

W. Green Electric Co., 130 Cedar St., New York, have announced the results of chromium plating tests made with the company's selenium type rectifier "Selectro-plater" as a source of current.

The tests were made at Brust Bros., Brooklyn, N. Y., who specialize on chromium plating and the tests were supervised by Adolph Bregman executive secretary of the Masters' Electro-Plating Association. The rectifier was hooked up to one of the decorative chromium plating tanks with Mr. Brust and his foremen personally handling the job.

The plating tests were made progressively, raising the voltage from 1 to 6 volts, with runs from 2 to 4 minutes, and in each case, a perfect result was reported. The tests were made to demonstrate that rectifiers perform satisfactorily for chromium plating, and the test reports indicated that the rectifiers are entirely suitable for chromium plating.

## New Respirator for Type A (Silica), Lead and Nuisance Dusts

A new respirator, said to incorporate increased comfort and fully efficient protective features, is announced by Chicago Eye Shield Company.

Called the "Cesco No. 94 Healthguard Respirator," the unit carries a recently issued approval by the U. S. Bureau of Mines (Approval Number BM-2142), for protection against type A (Silica), lead and nuisance dusts.

Outstanding among improvements claimed for the new respirator, is the manner in which the soft-moulded rubber face-piece fits low on the nose. This feature is said to eliminate obstacles to vision and enables the user to wear spectacles or goggles in conjunction with the respirator.

Operating features include a specially designed metal filter box that guards replace-



Dust respirator.

able filters, with an overall filtering area of approximately 40 sq. in. to promote easier breathing. Newly designed exhale valve incorporates a speaking diaphragm to permit a normal exchange of conversation.

The manufacturer states that the new No. 94 Respirator functions with a high degree of efficiency against all common dusts, making it unnecessary to change filters under average conditions.

Those confronted with dust problems who may be interested in obtaining more information about the protection claimed for the New No. 94 Respirator, may write to Chicago Eye Shield Company, Dept. 29, 2362 Warren Boulevard, Chicago, Ill.

## Automatic Sandblast

Leiman Bros., Inc., 101 LL4 Christie Street, Newark, N. J., have developed a new type automatic cabinet sandblast for cleaning metal cylinders and shells.

It is a four-nozzle machine for cleaning or finishing the inside and outside of tubing or solid pieces of work.

This cabinet sandblast is equipped with two rotating fixtures for holding and turning the pieces of work. The vertical nozzles travel longitudinally to clean or finish the outside surface of the revolving pieces on the fixture, while the side nozzles are used for cleaning the inside of any article which may be hollow.

The machine is all self-contained, the sand placed in the lower tapered section being automatically fed to the nozzles by means of the air pressure when it drops to the bottom of the machine again and is used over and over again.

The machine is heavily constructed of



Automatic sandblast.

sheet steel and all parts welded. It is equipped with a foot control lever by means of which the flow of the sand at the blast nozzles may be started or stopped by the attendant at will.

The lever shown at the top of the cabinet is used for the purpose of raising and lowering the nozzles in order to vary the surface effected as required in sandblasting any articles in the cabinet.

The rotating fixtures are motor driven but they may also be arranged for hand manipulation if so desired.

In operation, the front door is closed, when the progress of the work may be readily observed by means of the glass window directly over this door.

The machine, with its four blasting nozzles, it is said, may be adapted for a wide variety of work in metal, glass, plastics, Bakelite and any composition. Size of cabinet 36 x 48 inches; height of cabinet 68 inches.

## Tin Flux

A special tin flux called "Fas-Tin-Flux" is made by the Hanson-Van Winkle-Munning Company, Matawan, N. J. This product is a liquid of the zinc chloride type for use in hot tinning, in the manufacture of Terne plate (lead-tin alloy) and for soldering. Containing special addition agents to assure fast action, it is so made that it will be free from uncombined hydrochloric acid. A gallon weighs about 15 pounds and the standard 55-gallon drum contains about 800 pounds net.

Wherever possible, "Fas-Tin-Flux" should be used at full strength, but it may be diluted if desired. The preferred cycle for hot tinning is as follows:

## Professional Directory

### G. B. HOGABOOM, JR. & CO.

#### Consulting Chemical Engineers

Solution analysis, plant design, process development. Testing of deposits—composition, thickness, porosity, salt spray.

352 Mulberry St. Newark, N. J.

Any plating solution analyzed for \$1.  
Reagent solutions for analyzing 25c. pt.

#### Platers' Laboratory Service

P. O. Box 59, Elizabeth, N. J.



Remove grease from the work, rinse, pickle, cold rinse, dip in Fas-Tin-Flux and then into the tin pot. As far as possible, a flux fusion made from Fas-Tin-Flux should be kept on the tin pot and the entering work should pass through it. Close control of these features assures smoother coats, less pin holes or craters and longer resistance to the salt spray test. One of the users of this material for refrigerator racks has increased his salt spray test figures from 48 hours to about 125 hours, and 240 hours are realized quite frequently.

Extensive technical data are available to prove that rinsing after hydrochloric acid pickling must be done carefully and thoroughly to remove all the ferrous chloride possible. The more completely this is removed, the less scruff (similar to dross) is produced. A mere dip in cold water is not effective. A longer rinse in cold running water is better, and if the work can be scrubbed while in the water, the results are even better. This rinsed work should be put in the Fas-Tin-Flux at once to avoid any rusting. The formation of a film of greenish ferrous salts is certain to lead to poor coatings.

Fas-Tin-Flux may be poured on molten tin without danger of explosion. It will form a foamy flux blanket, which will tend to harden unless it is constantly supplied with water by a drip. This is intentional because zinc chloride is most effective as a flux when water is supplied with it to form hydrochloric acid gas in the fusion. If necessary, as much as 100 pounds of water can be used with each pound of Fas-Tin-Flux placed on the molten metal. Increased use of water leads to brighter coats.

Broadly speaking, the consumption of a zinc chloride tin flux depends on the amount of actual zinc chloride contained in the flux. Fas-Tin-Flux contains about 69% solids and 31% water. Common 50° Baume zinc chloride contains 47.4% solids, and the fast 50° flux about 51% solids. Approximately 135 pounds of these fluxes will be required to do what 100 pounds of Fas-Tin-Flux will accomplish. Aside from the 2% to 4% savings in freight, the more concentrated flux is preferable chemically.

### Nylon Brushes

Newly developed nylon bristled brushes which are said to resist many chemicals have been introduced to eliminate troublesome "semi-bottlenecks" of production in the electroplating industry, technologists of E. I. du Pont de Nemours & Company, Wilmington, Del. advise.

Interruptions for bristle replacement in the brush electroplating process have been sharply reduced, with a correspondingly speeded productive rate, by the use of nylon in place of imported hog bristle.

In some new processes, users of plating brushes reported, strong chemical compounds forbade the use of any bristles but nylon. These processes included new types of silver and cadmium solutions in which hog bristles swiftly deteriorated.

Development of nylon electroplating brushes, engineers emphasize, frees the brush-plating industry from its previous dependence upon uncertain supplies of the

## STAINLESS STEEL POLISHING COMPOUNDS

Are Proven Every Day in Every Kind of a Metal Working Plant



**"4-A" Polishing Compounds Are Faster, More Efficient, More Economical for Polishing, Mirror Finishing of All Kinds of Steel, Including Stainless Steel and Other Alloys.**

Use it on any kind of a wheel, soft, hard, medium. Results will speak more eloquently than anything we could say.

Tell us about your toughest job, and we'll be glad to send the "4-A" product that will solve your problem. No obligation, of course.

## CEMENT AND THINNER

Instead of glue, use "4-A" Cement and Thinner, a uniform substitute for polishing Wheels, Belts, Buffs, Rolls, etc.

Samples of Compound or Cement sent on request.

## HARRISON & COMPANY

HAVERHILL, MASS.

long hog bristles obtained from the Orient.

It has been found that hog bristles matted together badly, which prevented their picking up correct amounts of solution. They also deteriorated rapidly in cyanide and certain strong acid solutions. Extensive tests in the laboratory and in actual industrial operations show nylon bristles to be practically unaffected by normal plating solutions.

Bristles of the first brushes made for portable brush-plating equipment were ten thousandths of an inch in diameter. They held the electrolyte well but tended to scratch the thin, non-porous coats of such soft deposits such as silver. A softer brush was obtained by reducing the bristle diameter to five thousandths of an inch.

### New Type Metallizing Gun

The Metallizing Engineering Co., Inc., 21-11 41st Ave., L. I. City, N. Y., have announced the development of a new type metallizing gun called "Metco-Type 2E".

The metallizing process is said to be par-

ticularly advantageous for the restoration of worn machine parts of all kinds, such as bearing surfaces, rolls, shafts, pump rods, press fits, repairing casting defects, etc., using plain carbon steel, stainless steel, cop-



New metallizing gun.

# Each ONE handles 800 lbs. of FORGINGS...

*Boost payloads, speed  
production with  
pickling baskets of  
all-welded Monel*



*Monel baskets 40 in. x 13½ in. x 12½ in. deep, made from .156 gauge sheet, lifting books from 5/16 in. x 1 in. hot rolled Monel flats, by Youngstown Welding & Engineering Co., Youngstown, Ohio. Used for handling and pickling forgings in large Detroit auto plant, these 7 baskets are part of an order for 30.*

Speedy production with safe operation! Isn't that what you want in your pickling room these days? A big help in this direction is light-weight equipment of Monel.

This high-nickel alloy is exceptionally tough, strong and resistant to corrosion. Also easy to weld, with welds as strong and corrosion resistant as the parent metal, Monel assures for pick-

ling equipment lasting strength combined with light weight.

*Proof of the value of Monel pickling equipment? One of Detroit's big auto manufacturers some years ago tried out 2 Monel baskets. Result: The baskets shown above, part of an order for 30, make a total of 72 since ordered by this concern.*

Full information on use of Monel for crates, baskets, chains and other pickling equipment gladly mailed on request. Address:

THE INTERNATIONAL NICKEL COMPANY, INC., 67 WALL STREET, NEW YORK, N. Y.



## MONEL

"Monel" is a registered trade-mark of The International Nickel Company, Inc., which is applied to a nickel alloy containing approximately two-thirds nickel and one-third copper.

per alloys and nickel alloys. The process is also widely used for the application of corrosion resistant coatings of zinc, aluminum, lead, tin and other metals, to all types of equipment ranging from nuts and bolts to steel bridges, water tanks and ships. Aluminum coatings have proved successful in retarding heat corrosion or oxidation on exhaust manifolds, furnace parts and similar equipment.

The metal wire is automatically fed into the gun at an adjustable speed, where it is melted by means of concentrated flame, atomized by compressed air and sprayed on any base material. The gun may be used as a hand tool for coating large structures with zinc, aluminum, lead or other metals, or as a lathe tool for building up worn

shafts, rolls, plungers, etc., with steel, stainless steel, Monel metal, bronze or any other metal obtainable in wire form.

The Type 2E gun has two new outstanding features, the "controlled power unit", which is said to give absolutely uniform and steady wire feed for production service, eliminates the need for gear changes and the "universal gas head" allows the use of acetylene, propane, hydrogen, natural or manufactured gas with balanced pressures and without changing heads.

On the previous guns, the wire feed has been controlled by regulating the flow of air to the air turbine which provides the power for feeding the wire. This method had the disadvantages of considerable speed fluctuation under varying load, requiring

constant regulation by the operator and low power output at the slower speeds making gear changes necessary. The "controlled power unit" controls the wire speed by means of a governor, operating on the power absorption principle, thus allowing full power input at all times and eliminating speed fluctuations under varying loads and the necessity for changing the gears in the gun.

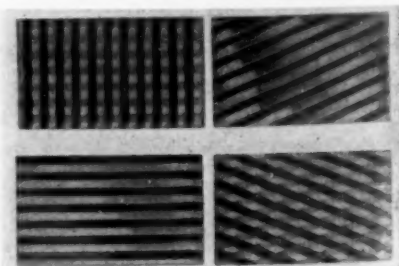
To change from one fuel gas to another, previous guns required either a change of gas heads, or the use of unbalanced gas pressures, which caused difficult lighting and danger of backfires. The new gas head allows operation on any of the usual fuel gases with balanced pressures, without changing heads or dismantling the gun in any way.

In addition this gun, according to the manufacturers, has improved spraying characteristics. Extremely fine coatings are claimed to be obtained at production speeds, and this combined with simplified adjustments, permits continuous operation with maintained speed and quality. Improved nozzle and jet construction reduce gas consumption and result in the deposit of a maximum efficiency and economy. Lightweight, perfect balance and easy hand grip combine to eliminate operator fatigue. Maximum air pressure required is only 65 p.s.i. Rugged in construction this gun is said to be ideal for heavy duty metal spray work.

The complete tool is extremely light, weighing only 4¼ lb. The gear case is made of aluminum alloy and is completely sealed. Simple two-piece case construction combined with removable drive gear and roll make the unit easy to clean and inspect. Precision ball bearings are used throughout. Bearing housings constructed of brass are mounted in the case. All parts effecting alignment are assembled with dowel pins or cylindrical fits. Alignment is not dependent on threaded sections. Worms are cut integral with their shafts and are ground after hardening. Wire nozzles are of bronze with a hardened, heat-proof lining which will not fuse or stick to the metal being sprayed. Gas head is made of a dense pressure tight bronze, and separated completely from the case assembly, eliminating any danger of inflammable gases collecting in the case. All parts are completely interchangeable, and may be assembled without adjustments.

### New Pre-finished Metals

The introduction of several interesting, new crimped designs in bonded pre-finished metals has been announced by the American Nickeloid Company, Peru, Illinois.



New designs of pre-finished metals.

One of these, termed a " $\frac{1}{8}$ " crimp", is available in horizontal, diagonal, square, and diamond patterns in a variety of metal thicknesses. Sheet size available in most patterns up to 24 x 36".

The second design, termed an "oval crimp," is introduced in two widths— $\frac{1}{8}$ " and  $\frac{3}{16}$ " in long, continuous coils, and in gauges ranging from 0.010" to 0.015".

Both crimps are offered in bright or satin finishes of nickel, brass, chromium, or copper electro-bonded to basic metals of steel, zinc, or brass.

The rounded contour of the oval crimp makes it very adaptable for inlay purposes, and it is finding a ready market in this field. The  $\frac{1}{8}$ " crimp is being offered for a variety of purposes including reflectors, stove pads, electrical appliances, display stands, signs, and any application that requires a new decorative treatment.

The manufacturer states samples of the two new patterns will gladly be supplied to interested users.

### New Polishing and Buffing Lathes

Bruce Products Corporation, 5712 Twelfth Street, Detroit, Mich., announce the addition of several new models of polishing and buffing machinery.

Features incorporated in these new adjustable speed and selective speed models are:

Wheel spindle bearings are high capacity, precision type, full floating mounted, effectively enclosed to eliminate leakage of lubricant and entrance of abrasive dust.

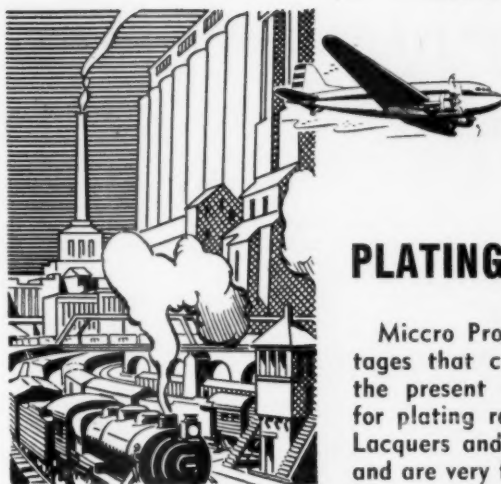
Wheel spindles are all precision machined from X1335 SAE alloy steel and each spindle is checked for dynamic balance. All lathes having a maximum speed of 3600 R.P.M. are tested for a critical speed of 4200 R.P.M., thereby allowing a generous margin for a factor of safety. Models operating higher than 3600 R.P.M. carry the same generous margin.

V-belt sheave on wheel spindle is accurately machined and balanced on wheel spindle prior to assembly. Integral with the sheave member is a tubular extension, provided with four slots to permit the plunger type spindle lock pin engaging same in four stations. Sheave is positively anchored to spindle.

V-belts are supplied in matched sets. Two belts used for 3 HP.; three for 5 HP.; four for 7½ HP. and five for 10 HP., all belts of "B" section.



Operators working at new polishing and buffing lathe.



## Speed

### IS IMPORTANT IN PLATING OPERATIONS, TOO

Miccro Products offer time-saving advantages that can be extremely important at the present time. As protective coatings for plating racks, Miccro Supreme Stop-Off Lacquers and Miccrolite are applied quickly and are very fast drying. The required number of coats can be applied in one day and

the racks can be used the next.

Of even more importance, these protective coating materials are made for use in your own plant. You experience none of the delays caused by dependence on outside sources of supply for handling the work. If racks should be damaged in process, they can be touched up immediately with the patch becoming an integral part of the entire coating.

Miccro Supreme Stop-Off Lacquers, used for masking parts for hard chromium plating, dry very rapidly and can be removed quickly and easily after plating. Miccrolac—the new water-white material used to protect and beautify natural and plated finishes—also provides unequalled time- and labor-saving features.

Miccro Products will definitely meet your requirements in aiding to speed production. Write for full information.

## Miccro Supreme STOP-OFF LACQUERS MICCROLITE . MICCROLAC

**MICHIGAN CHROME & CHEMICAL CO.**  
6348 EAST JEFFERSON . DETROIT, MICHIGAN

Bases are of sufficient weight to provide rigidity and stability for heavy duty service.

Adjustable speed single or double spindle lathes are equipped with Reeves Moto-Drive internal mechanisms, easily adjusted through the speed ranges by small indicators on the top of the lathe. The shafts on these mechanisms are hard chrome plated and will never corrode or wear during the life of the machine.

Bruko's Machine Division catalogue covering full specifications on all models will be sent on request.

### Manufacturers' Literature

#### Abrasive Materials

The Abrasive Co., Division of Simonds Saw and Steel Co., Tacony and Fraley Sts., Philadelphia, Pa., have issued a new beau-

tifully illustrated "Plant View Book" showing in complete detail the various manufacturing processes and plant facilities used in the production of the company's grinding wheels and abrasive materials. The book is 11" x 14" in size with 24 pages and cover. It is largely pictorial, with clear photographs of both outside views of parts of the plant, and of inside views of the various processing steps from the start of the manufacture of grain to the finish of bonded wheels. The company will be pleased to send copy to interested plant executives and operating officials.

#### Burn Kit

The Mine Safety Appliances Co., Brad-dock, Thomas and Meade Sts., Pittsburgh, Pa., have issued a folder describing and illustrating the "Foilie Spray Kit" for first-aid treatment for burns. The kit includes a spray gun with material contained therein for ready treatment of burns. Accessory equipment, such as bandages, scissors, oil, etc., is included.



## METALWASH MOTORIZED Washing Machines and Rinse Tanks for Job Shops and Plant Inter-Departmental Use

METALWASH Machines are the result of 16 years of research and engineering experience.

Other types of auxiliary wash and rinse equipment are available, which have been built to order for special requirements of various classes of plating establishments.

Our engineering department will be glad to consult with you on your particular problem.



Power Spray  
Washing Machine

This machine is expressly designed for washing parts with a minimum operating cost. Mechanical force of the spray plus the chemical action of the alkaline solution or water solvent removes every particle of buffing compound from difficult surfaces and crevices.



Foot  
Control  
Rinse Tank

This unit is used in plating rooms where quick efficient rinsing is accomplished without the necessity of the plater relinquishing his work or plating rack. Powerful sharp cutting sprays, constantly brushing downward on the work remove heavy plating fluids and insure perfect rinsing.

The unit is connected to the water supply line; and can also be furnished for both hot and cold water.

**METALWASH MACHINERY CO., Inc.**  
27-29 Haynes Avenue  
Newark, N. J.



# When BEST it's FELT

Companies that make their product look worth the difference to the buyer use Paramount Brand Felt Polishing Wheels to polish the base metal, knowing that to have the best finish, you must start right, which means, Paramount Felt Polishing Wheels,

Ask Your Supplies Salesman  
for PARAMOUNT BRAND

**BACON FELT CO.** WINCHESTER  
MASS. ESTABLISHED  
1824

### Cleaners

Magnuson Products Corp., 3rd and Hoyt Sts., Brooklyn, N. Y., have recently published a folder describing various cleaning compounds made by the company for cleaning car exteriors, air conditioning units and other parts of rolling stock. The advantages of the company's cleaners are outlined and directions are given for their use.

### Metallizing

Metallizing Engineering Co., Inc., 21-07 41st Ave., L. I. City, N. Y., have just issued a new 16-page informative bulletin No. 42, entitled, "Metco Metallizing Equipment and the Metallizing Process", which gives information on production and maintenance work, using the company's metallizing process. The bulletin describes in detail the company's new metallizing spray gun, "Type 2E", as well as the standard "Type E Gun". Various accessories are also described. The metallizing process is used for rehabilitating worn shafts and other rotating machinery as well as for protecting metal surfaces against corrosion and other chemical attack.

### Metal Working Processes

Wayne Chemical Products Co., 9600 Cope-land Ave., Detroit, Mich., have available a new folder catalog which consists of a folder containing separate literature on the company's various products, designed for the metal working industry. These products include rust-proof materials, drawing compounds, solders, polishing compounds, lubricants, cleaners, soaps and fluxes.

### Porcelain Enamels

Porcelain Enamel & Mfg. Co., Baltimore, Md., describe the company's porcelain enamels, both ground coats and cover coats, in a recently published, illustrated, folder.

### Rubber Goods

Paramount Rubber Service, Inc., 1430 Rosedale Court, Detroit, Mich., have recently published literature describing various solid rubber and rubber coated products made by the company. These include anode savers for plating of scrap metal, rubber coated plating racks, rubber acid pitchers and various handy tanks.

### Rubber Paint

Paramount Rubber Service, Inc., 1430 Rosedale Court, Detroit, Mich., describe their rubber paint in a recent bulletin. The paint is said to be ideal for protection of metals, concrete, stone, etc., against abrasion and corrosion. It is available in black and gray colors. It is claimed that 1 gallon will cover 300 sq. ft. of metal. Results of a 1000-hour abrasion test are also described to illustrate the resistance of this rubber paint to mechanical abrasion.

### New Books

*Proceedings of the 43rd Annual Meeting Vol. 40, 1940.* Published by the American Society for Testing Materials, Philadelphia.

Pb. Size 9" x 6"; 1361 pages. Price: \$8.50, heavy paper binding; \$9.00 cloth; \$10.00, half-leather.

These Proceedings, issued annually in one volume (prior to 1939 the volumes were in two parts) include the many important committee reports and appended material presented at the annual meeting, and the technical papers and discussions affording valuable data and information on the properties and tests of engineering materials.

Not only do the reports of A.S.T.M. committees give full details of the important recommendations on specifications and standardized test methods for materials, but in many cases they include important data and information in the form of appended reports or papers. Nine of the reports pertain to ferrous metals, including steel, cast iron, corrosion of iron and steel, magnetic properties, malleable iron castings, fatigue of metals, effect of temperature on the properties of metals, and iron-chromium-nickel and related alloys. The latter report includes an appended item on inspection of stainless steel architectural structures. Other appended papers cover a study of effect of variables on the creep resistance of steels and a list of published reports with reference to tests on 0.35 per cent carbon steel K20.

Seven reports involve non-ferrous metals including copper and copper alloy wires for electrical conductors, non-ferrous metals and alloys, corrosion of non-ferrous metals and alloys, electrical heating, electrical resistance and electric furnace alloys, copper and copper alloys—cast and wrought, die cast metals and alloys and light metals and alloys—cast and wrought.

Subjects of other reports include paint, varnish, lacquer and related products; petroleum products and lubricants (three proposed methods appended); gaseous fuels; road and paving materials (proposed method and specification appended); coal and coke; paper and paper products; timber; bituminous waterproofing and roofing materials; electrical insulating materials; rubber products (three proposed methods appended); soaps and other detergents (two proposed specifications appended); textile materials; naval stores; soils for engineering purposes; water for industrial uses; and plastics.

A considerable portion of the Proceedings papers relate to ferrous and non-ferrous metals (including the tension test symposium, 450 pages). Several papers relate to questions of corrosion, the effect of protective coatings on the corrosion fatigue strength of steel, fatigue tests on zinc coated steel wire, the fatigue strength of 2-inch diameter axles and of porous metals. There are also papers relating to materials at high temperatures and an interesting discussion on high speed tension tests at elevated temperatures.

Three of the non-ferrous metals papers pertain to lead cable sheathing and coverings and four papers comprise a topical discussion on anodic coatings.

There are extensive papers on cements, concrete and concrete mixtures, concrete creep and volume changes, relation of water

## THE DIAL DOES IT



SPEED CHANGES—1500—3000 RPM INSTANTLY  
WITH HAMMOND'S NEW "VRO" POLISHING LATHE



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- ★ BUFFING
- ★ COLOR BUFFING

Better and more uniform finish invariably is the result with HAMMOND'S new "VRO" Variable Speed Polishing Lathe . . . because it keeps peripheral speed constant as wheels wear down.

The dial control . . . mounted directly in front of the operator . . . does it. It's sensitive to the slightest touch . . . gives you instant, point-by-

point speed control all the way from 1500 to 3000 RPM. The "VRO" is big, tough . . . built for hard service . . . yet incorporates the latest design features. The "overhang" permitting

awkward shapes to be brought up to the wheel without difficulty is an outstanding feature.

But you'll want to know all about it . . . so write today for BULLETIN No. GP-30.

OR ASK ABOUT ROTARY OR STRAIT-LINE AUTOMATICS

# Hammond of Kalamazoo

HAMMOND MACHINERY BUILDERS, INC.  
1601 DOUGLAS AVE. • KALAMAZOO, MICHIGAN  
Eastern Branch—71 West 23rd Street, New York City

absorption and strength of brick to abrasive resistance.

A miscellaneous group of papers comprises four discussions on asphalt and asphalt tests, oxidation of mineral insulating oil, creep in ropes and cords, and two interesting papers on accelerated weathering of transparent plastics and the sorption of water by plastics.

## Obituaries

### Louis Kahlenberg

Louis Kahlenberg, professor of chemistry at the University of Wisconsin, died March 18 in Florida.

Dr. Kahlenberg was born in Two Rivers, Wis., January 27, 1870. He received the B.S. degree from the University of Wisconsin in 1892 and the M.Sc. in 1893, and

in 1895 was granted the Ph.D. *summa cum laude* by the University of Leipzig. The same year he joined the staff of the University of Wisconsin, being instructor from 1895 to 1897, assistant professor of physical chemistry from 1897 to 1900, professor from 1900 to 1907, professor of chemistry since 1907, and from 1908 to 1919 chairman of the Chemistry Department and director of the course in chemistry.

He was the author of many books, monographs, and articles on scientific subjects, including "Laboratory Exercises in General Chemistry", "Outlines of Chemistry", "Qualitative Chemical Analysis" with J. H. Walton, and "Chemistry and Its Relation to Daily Life" with E. B. Hart.

He had been a member of the American Chemical Society since 1898, and had served as local section chairman, local section councilor, and Councilor-at-Large. Other scientific society affiliations included the American Association for the Advancement of Science, Wisconsin Academy of



# A Reminder

**PERIODIC TREATMENT OF BRIGHT  
NICKEL PLATING SOLUTIONS WITH  
NUCHAR ACTIVE CARBON GIVES THESE ADVANTAGES:**

1. Improves quality of plating.
2. Avoids the necessity of extra buffing.
3. Eliminates a tendency to brittleness in plated nickel.

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230 Park Avenue

New York

Sciences, Arts, and Letters (president from 1906 to 1909), American Electrochemical Society (vice president from 1902 to 1907 and from 1910 to 1912 and president in 1930-31), Washington Academy of Sciences, History of Science Society, American Society of Plant Physiologists, and the Wisconsin State Historical Society.

### Charles Zang

Charles Zang, owner of the Franklin Plating & Polishing Co., died on March 16, 1941, in his 72nd year. He had been in ill health since he suffered a stroke three years ago. He was a native of France, and went to Columbus, Ohio, fifty years ago, and had conducted his plating business for the past forty years.

Mr. Zang is survived by six sons and six daughters and twenty-seven grandchildren. Funeral services were held at St. Mary's Church, Columbus, and he was buried in St. Joseph's Cemetery.

### Malcolm MacDonald

Malcolm MacDonald, 153 Willow Place, Sherrill, N. Y., passed away on February 15th, after months of suffering. He had been with Oneida, Ltd., several years longer than the twenty-two as foreman of the plating department.

Mr. MacDonald was born in Dover, N. H., fifty-seven years ago, and after graduating from high school, he attended a Boston law school.

He will be missed by many friends and business associates. His wife, Mattie MacDonald, survives him.

### Spring Meeting of Ohio Branches

May 10—Cleveland, Ohio

Cleveland—Dayton—Toledo

Cooperating Branches A.E.S.

## Associations and Societies

### American Electroplaters' Society

#### Tentative Program of Annual Convention

Boston, Mass.—June 9-12

#### Sunday, June 8

3:00 P.M. Registration: Mezzanine floor, Statler Hotel. Registration Fees: Gentlemen \$5.00; Ladies \$5.00. This entitles registrant to book of tickets to be used for all functions and activities. Membership in the Society is not necessary for registration.

#### Monday Morning, June 9

8:00 A.M. Registration: Mezzanine floor, Statler Hotel's Georgian Room.

9:00 A.M. Welcome to delegates, members and visitors by Joe Barron, General Chairman.

Address: Wm. Jones, President, Boston Branch.

Welcome to Boston: The Honorable Mayor Maurice J. Tobin.

Presidential Address: Frederick Fulforth, President of the American Electroplaters' Society. Business Session. Presentation of Credentials. General Reports.

#### Monday Afternoon, June 9

2:00 P.M. First Educational Session: Georgian Room, mezzanine floor. Arranged by the Educational Committee, A. W. Collins, Chairman. John E. Costigan, Springfield Branch, presiding.

1. "Application of Salt Spray Test to Electroplated Coatings". By Dr. Wm. Blum, National Bureau of Standards, Washington, D. C.

2. "Advantages and Objections to the Salt Spray Test from an Electroplating Point of View". By Albert Hirsch, Snyder, Inc., Philadelphia, Pa.

3. "The Use of Rubber in the Plating Room". By C. P. McHugh, Chemical Engineer, Manhattan Rubber Mfg. Division, Raybestos Manhattan, Inc., Passaic, N. J.

4. "Electropolishing". By Dr. H. H. Uhlig, Research Division, General Electric Co., Schenectady, N. Y.

5. "Measurement, Significance and Control of pH in Cyanide Plating Baths". By A. G. Gray, Electroplating Division, E. I. duPont de Nemours & Co., Inc., Cleveland, Ohio.

#### Monday Evening, June 9

8:30 P.M. International Fellowship Club Open House: Grand Ballroom of the Hotel Bradford (few blocks from Convention Headquarters). This evening's entertainment is sponsored by the International Fellowship Club. A ticket for this affair is included in registration booklet. Dancing—Buffet Supper (served



by ticket only). Fun—Music—Get Together—Get Acquainted.

#### Tuesday Morning, June 10

8:45 A.M. 2nd Educational Session: Georgian Room, mezzanine floor. *P. R. Lyons*, Cleveland Branch, presiding.

1. "Composition of Cathode Films". By *Dr. Abner Brenner*, National Bureau of Standards, Washington, D. C.
2. "Electrocolor and Patternplate". By *Dr. J. E. Stareck*, United Chromium, Inc., New York.
3. "Nickel and Copper Deposition in the Printing Industry". By *James E. Dowd*, Electrotype Division, the Conde Nast Publications, Inc., Greenwich, Conn.
4. "Polishing Steel Specimens Prior to Plating for Exposure Test". By *Gerald A. Lux*, Research Associate, A. E. S., Washington, D. C.
5. To be announced.

#### Tuesday Afternoon, June 10

12:00 P.M. Sharp. Trip through the Whiting and Davis plant, Plainville, Mass., manufacturers of ladies' mesh bags, where luncheon will be served at the Whiting & Davis Co. Cafeteria, by ticket only, through the courtesy of Frederick Gumm Chemical Co.

3:30 P.M. Trip through the Warren Telechron Co., manufacturers of Telechron Clocks, Ashland, Mass. The world's largest electric clock manufacturers.

#### Tuesday Evening, June 10

8:00 P.M. Third Educational Session: Georgian Room, mezzanine floor.

*W. M. Phillips*, Detroit Branch, presiding.

1. "Throwing Power of Plating Solutions". By *G. B. Hogaboom*, Hanson-Van Winkle-Munning Co., Matawan, N. J.
2. "Effects of Impurities in Plating Solutions". By *Dr. Walter R. Meyer*, Editor, Metal Finishing, New York.
3. "Physical Removal of Impurities from Plating Solutions". By *Walter A. Helbig*, Chemical Engineer, Darco Corp., New York.
4. "Chemical and Electrochemical Methods for the Purification of Plating Solutions". By *O. A. Stocker*, Electrochemist, The Rufert Chemical Co., Division of the Seymour Mfg. Co., Seymour, Conn.
5. "Removal of Chromium Contamination in Alkaline Plating Solutions". By *Dr. M. M. Beckwith*, J. B. Ford Sales Co., Wyandotte, Mich.
6. "Electroplating Education". By *Dr. C. B. F. Young*, Head, Institute of Electrochemistry and Metallurgy, New York; Consultant.

#### Wednesday Morning, June 11

8:30 A.M. Buses leave promptly from Hotel Statler for a beautiful morning tour to the landing place of the Pilgrim fathers; historic Plymouth, Mass., and Pilgrim Shore, going through Quincy, Weymouth, Hingham, Duxbury, and Marshfield. Buses leave Plymouth at 1 o'clock for Pemberton Inn, Hull, Mass., for a New England shore dinner (included in registration booklet). Ocean swimming—Golf Tournament—East vs. West Baseball

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## 99.75% PURE

Stocks of Mutual Chromic Acid are available in all principal industrial centers, where Mutual distributors stand ready to give complete technical service supplemented and supported by the research and development facilities of the world's largest manufacturer of chromium chemicals.

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*Mutual Chemical Co. of America*

270 MADISON AVENUE, NEW YORK

Game—Recreation Games.

#### Wednesday Evening, June 11

8:00 P. M. Fourth Session: Georgian Room, mezzanine floor, Hotel Statler.

*Dr. Walter R. Meyer*, Bridgeport Branch, Presiding.

1. "The Uses and Limitations of Radiant Heat for Baking Organic Finishes". By *Gustave Klinkenstein*, Vice-President, Maas & Waldstein Co., Newark, N. J.
2. "Modern Methods of Copper Plating". By *F. F. Oplinger*, Electroplating Division, E. I. duPont de Nemours & Co., Wilmington, Del.
3. "Electropolishing Stainless Steel in Phosphoric-Sulfuric Acid Baths". By *C. L. Faust* and *H. Pray*, Battelle Memorial Institute, Columbus, Ohio.
4. "Unichrome Copper". By *T. G. Coyle*, United Chromium, Inc., New York.
5. "The Contamination and Cleaning of Cold Rolled Steel". By *Ernest H. Lyons*,

Jr., Chemist, The Meaker Co., Chicago, Ill.

#### Thursday Morning, June 12

9:00 A. M. Fifth Session: Georgian Room, mezzanine floor, Hotel Statler.

*Charles T. McGinley*, St. Louis Branch, Presiding.

1. "Copper Oxide Rectifiers for the Electroplating Industry". By *I. Albert Lee*, Bridgeport, Conn.
2. "Die Cast Finishing". By *Martin F. Maher, Jr.*, New York Branch.
3. "An Educational Program for Everyone". By Rochester Branch.
4. Cincinnati Branch—to be announced.
5. "Electrolytic Polishing". By *Harold M. Lang*, New York Branch.

#### Thursday Afternoon, June 12

1:30 P.M. Georgian Room, mezzanine floor, Hotel Statler. Final Business Session—Election of Officers—Selection of the

# WHY DO COWLES METAL CLEANERS PERFORM *Better* AND GO *Farther?*



*Because*

Cowles engineers are constantly studying your problems:

1—The requirements of metal cleaning in plants like yours;

2—The specific cleaning power available of each detergent base material.

As a result, Cowles brings you the best detergent materials for your cleaning purposes—carefully engineered into the most efficient, most economical proportions for money-saving performance.

There is a Cowles Metal Cleaner for every cleaning job. You'll do it *Better, Quicker, and More Economically* with COWLES METAL CLEANERS.



**THE COWLES DETERGENT COMPANY**  
Metal Cleaner Department  
7016 EUCLID AVENUE • CLEVELAND, OHIO

*Cleaner Surfaces for Better Finishes*

1942 Convention City.

## Thursday Evening, June 12

7:00 P.M. Banquet—Stage Show—Dancing.  
Hotel Statler, Main Imperial Ballroom,  
mezzanine floor.

## Ladies' Program

## Sunday Afternoon, June 8

3:00 P.M. Registration.

## Monday, June 9

9:00 A.M. Attend opening of convention.  
The ladies will then meet in the Imperial  
Ballroom Foyer of the Hotel Statler for  
an informal period to get acquainted and  
review the week's activities

1:00 P.M. Luncheon will be served in the  
Palm Room of the Hotel Statler. Follow-  
ing the luncheon, the International Fel-  
lowship Club will sponsor a "Beano"  
party in the Imperial Ballroom Foyer,

under the direction of *Joan Trumbour*.  
Prizes will be awarded.

8:30 P.M. The International Fellowship  
Club cordially invites all registrants, men  
and women, to attend their Open House  
and Buffet Supper, by ticket only, in the  
Grand Ballroom of the Hotel Bradford.  
There will be dancing and entertainment,  
and this promises to be an outstanding  
success, judging from their previous  
parties.

## Tuesday, June 10

9:15 A.M. Sight-seeing trip around Bos-  
ton. The ladies will meet in Room 419  
of the Hotel Statler, official meeting place  
for the ladies throughout the remainder  
of the convention. This tour should prove  
to be of great interest to everyone. Stops  
will be made at such places as Bunker  
Hill Monument, Faneuil Hall, etc.

12:30 P.M. Luncheon will be served at the  
famous Seiler's 1775 House in Lexington,  
Mass. There will be a distribution of

gifts with the compliments of the A.E.S.  
2:00 P.M. The historic towns of Lexington  
and Concord will be visited; also Cam-  
bridge, taking in Harvard University, and  
Agassiz Museum to see the world famous  
glass flowers, etc.

7:30 P.M. The ladies will meet in Room  
419, ready to leave by taxi to Symphony  
Hall to hear a "Pops" concert by the  
Boston Symphony Orchestra under the  
direction of *Arthur Fiedler*. Light re-  
freshments will be served during the con-  
cert through the courtesy of the *M. E.  
Baker Co.*

## Wednesday, June 11

8:30 A.M. An all morning bus cruise down  
the Atlantic Coast for both men and  
women to historic Plymouth, taking in  
Quincy, Weymouth, etc., on the way to  
the Cape.

2:00 P.M. Lunch at Pemberton Inn, Hull,  
Mass. Music, dancing, and sport activi-  
ties, etc.

8:30 P.M. The ladies are cordially invited  
by Oakite's *David X. Clarin*, Aunt Ella's  
personal secretary, to attend the Third  
Annual Party of the Aunt Ella Society,  
in Parlors D and E, Hotel Statler. Old-  
fashioned song festival and light refresh-  
ments. Courtesy Oakite Products, Inc.,  
New York.

## Thursday, June 12

10:15 A.M. Meet in Room 419, Hotel Stat-  
ler. Visit Isabella Stewart Gardner Mu-  
seum, Fenway.

7:00 P.M. The annual Banquet and Dance.

## Los Angeles Annual Meeting

The annual educational session of Los  
Angeles Branch, A.E.S., was held on Satur-  
day, March 22. The program consisted of  
an all-day business session, divided into  
morning and afternoon sessions; a compre-  
hensive display of members' work of art and  
finished materials in which 36 booths were  
operated by 28 different firms; and the an-  
nual dinner dance, the branch's outstanding  
social event of each year, in the evening.

The scene of the affair was the Los  
Angeles Breakfast Club, near the Glendale  
city limits. The club was a happy choice,  
for its spacious banquet hall lent itself to  
convenient arrangement of the many exhibit  
booths, while a separate auditorium accom-  
modated the business sessions.

The business sessions opened at 10:30  
A.M. with President, *Don Bedwell*, defining  
the objectives of the conference in a brief  
welcoming address.

Mr. Bedwell then introduced *E. R. Hol-  
man*, who as head of the educational com-  
mittee, served as chairman of the annual  
session. The first programmed feature was  
the showing of an industrial film entitled,  
"Norton Abrasives at Work", by *W. H.  
Turner*, representing the Norton Co.,  
Worcester, Mass. The film, accompanied  
by a running discourse by a commentator,  
depicted the various purposes for which  
abrasives in rounded, flat, elongated and  
block form are used, including their numer-  
ous applications in the electroplating and  
finishing industry.

The first formal address began at the close of the film with the introduction by Mr. Holman of *Herold J. Kroesche*, sales engineer, A. J. Lynch Co., Los Angeles.

"Coatings for Electroplated Ware" was the subject of the next paper which was presented by *Milton M. Loeserman*, research engineer, Pabco Research Laboratories, Division of the Paraffine Co., Inc., Los Angeles.

Mr. Loeserman briefed the elemental phases for electrodeposition of some 16 metals and the methods for depositing the coatings, in the opening phases of his talk. He passed then to a consideration of the properties required of the coating—its general requirements of adhesion, abrasion, resistance, toughness, etc.

At the conclusion of Mr. Loeserman's address, *Ernest Lamoureux* read a telegram from *Frederick Fulforth*, supreme president of the A.E.S., sent from Jenkintown, Pa.

Out-of-town visitors introduced by Chairman Holman at the close of the morning business session included *T. G. Coyle*, United Chromium, Inc., Detroit, a member of Detroit Branch; *Richard Herbst* of Santa Barbara, Calif., and *B. A. Fuens* of San Diego.

At noon 85 members and visitors attended an informal luncheon served in the dining hall of the Breakfast Club. Speeches were taboo at this luncheon, which was enlivened by the songs and accordion playing of *Betty Gordon*, who had made quite a "hit" at the March 12 meeting of the branch.

The afternoon session opened at 1:15 o'clock with a three-reel motion picture, "Leaching, Concentration, Smelting and Refining of Copper". The film was one prepared by the U. S. Department of the Interior, Bureau of Mines Experiment Station, Pittsburgh, Pa.

An easy and dependable method for controlling the process of anodizing aluminum alloys was the theme of an address on "Chromic Acid in the Aircraft Plant", which was delivered by *Paul P. Mozeley*, engineer of the Materials and Process Group of Lockheed Aircraft Corp., Burbank, Calif.

The important things to remember when directing the operation and maintenance of a solvent degreaser were outlined by *O. B. Moe* of G. S. Blakeslee & Co., Cicero, Ill., in a paper entitled, "Care and Maintenance of Vapor Degreasers".

Greeted by prolonged applause by Los Angeles members who recalled his masterful talk on "Principles of Detergency", which he delivered at the 1940 educational session, was the next speaker, *Dr. T. K. Cleveland* of San Francisco, chemist of the Philadelphia Quartz Co. Dr. Cleveland this time spoke extemporaneously on some properties of alkaline cleaning solutions. He illustrated many of the points with slides and interrupted his discourse at times to make actual tests in the convention hall of various alkalies in cleaning solutions.

The concluding speech was presented by *F. A. Maurer*, engineer of processes, General Electric Co., Ontario, Calif. His subject was "Cleaning and Bright Plating Iron and Steel Parts of Electric Irons".

The annual dinner dance was held in the

## NOW THE NEW AND STILL BETTER!

# UNICHROME\* "AIR DRY" RACK COATING

A rack insulation that is phenomenally resistant to boiling cleaners and all plating solutions, and is

## AIR DRYING!

*All You Do is Dip Rack and Let it Dry!*

Here is a new Unichrome\* rack insulating coating that is miles ahead of any rack insulating you ever tried or heard of.

It is even better than the famous Unichrome\* Rack Coating-W!

—Because this new Unichrome "Air Dry" Rack Coating has every one of Rack Coating-W's remarkable combination of advantages.

—And adheres in severe plating cycles still better than does Rack Coating-W.

—And cuts more easily at the contacts.

But has the immensely important added advantage of being AIR DRY-ING.

No hot dipping or force drying. All you do is simply dip your racks at room temperature and let them dry in the air after each coat.

Here's the story—seven big money-saving, trouble-saving, time-saving advantages:

- (1) Insoluble—withstands hot cleaners and all plating solutions.
- (2) Harmless—contains no ingredients harmful to plating solutions.
- (3) Tough—withstands wear and tear of handling.
- (4) Flexible—withstands repeated flexing and bending.
- (5) Durable—reduces need for re-coating.

(6) Easily Applied—simply dip and let dry.

(7) Convenient—any part can be patched without re-coating rack.

Write for Bulletin 27

Containing Complete Information—

Platers without rack coating facilities may have their racks coated with "Unichrome" "Air Dry" Rack Coating by Chromium Corporation of America, 4645 West Chicago Avenue, Chicago, Ill. Belke Manufacturing Company, 847 North Cicero Avenue, Chicago, Ill. or United Chromium, Inc., of Waterbury, Conn.

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## A NEW NICKEL STRIPPING PROCESS USING

# STRIPODE

(Patent applied for)

An inhibiting agent for Sulphuric Acid strip baths that—  
**PREVENTS PITTING AND ROUGHENING  
OF THE BASE METAL**

(Steel, brass, zinc die castings, heavy zinc and lead bearing alloys)

# STRIPODE

Reduces Finishing Costs to a Minimum

Reduces Stripping Time by 50% or More in Many Cases

Reduces Your Scrap Loss

Strips Plating Racks

Saves Acid

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## 147 STANDS OUT!

Wyandotte Metal Cleaner 147 is doing big things in a big way. When put to work electro cleaning zinc base die castings prior to plating it stands out for its swift action, for its thorough cleaning, for its economical work.

One plant cleans 50,000 pieces daily with Wyandotte 147.

Use Wyandotte 147 at four ounces to the gallon, with reverse current at 180° F., and you will find it leaves a beautiful color on the zinc base die casting without destroying the high lustre. There is no blistering when the plated parts are put through the

drying oven at 275° F. after painting.

Wyandotte 147 has extremely long life in solution. It will pay you to ask your Wyandotte Service representative to demonstrate the high efficiency of this new Metal Cleaner. Call him today.



Service Representatives in 88 Cities

THE J. B. FORD SALES CO.  
WYANDOTTE, MICHIGAN

main ballroom of the Breakfast Club beginning at 8 p.m. Attendance was 271, the largest, according to a subsequent report of the Banquet Committee, in the history of the branch.

Marcus D. Rynkofs, chairman of the Banquet Committee, acted as master of ceremonies. He made himself instantly popular with the audience by confining his "speech-making" to a few brief welcoming remarks, a decision which the audience applauded with a burst of exaggerated applause.

Don Bedwell was on duty as chairman of the Prize Committee. With commendable savoir-faire, and the able assistance of Bruno Schindler and Carroll McLaren, he negotiated the pitfalls of the drawing for door prizes with little more than a few dozen good-natured boos and Bronx cheers from those who were slightly disappointed at winning a brass plated doorknob, while

someone at the same table garnered a beautiful chromium plated foglight or a floor lamp. Bruno Schindler handled the microphone on the stage and his deep basso reverberated, a la Nelson Eddy, through the large auditorium to the call of "Come and get it; it won't walk to you", whenever a prize winner was tardier than Mr. Schindler thought appropriate in coming for his prize.

The educational session dinner dance committee which directed the affair was composed of the following: M. D. Rynkofs, committee chairman; Ervin Frauenthoff, committee secretary, and C. E. Thornton, Ernest Lamoureux, Earl Coffin, Bruno Schindler, E. R. Holman, Carroll McLaren, D. N. Eldred and Don Bedwell.

## Personals

### Pray Named Head of Battelle Electrochemical Research

Dr. H. A. H. Pray has been named head of a new division of electrochemical research at Battelle Memorial Institute, Columbus, Ohio. The work of the Institute on electroplating, surface treatment and corrosion of metals has grown very rapidly during recent years and has necessitated a considerable enlargement of staff and facilities for this phase of the Institute's research for industry.

In the field of electrochemistry, Battelle Director Clyde E. Williams stated that the Institute has done outstanding work in electrodeposition, anodic treatment of metal surfaces, pickling, corrosion, and corrosion protection. The division is equipped for electrodeposition of metals and alloys on a pilot-plant scale and for laboratory and outdoor corrosion testing. Eleven electroplating and corrosion specialists are employed.

Alloy plating, of growing importance to industry today, has long been studied by Battelle engineers and several alloy plating and bright plating processes have been developed.



Dr. H. A. H. Pray

Extensive studies of corrosion have been made, particularly under industrial conditions. In this connection, corrosion-resistant alloys and protective coatings for special purposes have been developed. The division has been instrumental in the development of commercial, low-alloy, high-yield-strength steels.

An outstanding achievement of the Battelle electrochemical research laboratories is a process for the electrolytic polishing of metals. The Battelle process, originated by Dr. Charles L. Faust, of the electrochemical division's technical staff, has a great many

industrial applications and makes available at relatively low cost a superior surface finish for stainless steel, steel, nickel, copper, brass, and zinc.

Dr. Pray, who has had years of experience in physical and inorganic chemistry as related to industrial problems, has been a member of the Battelle staff since 1934. Previous to that time he held professorships at several universities. He possesses B.S. and M.S. degrees granted by Oberlin College and received his doctorate from the University of Wisconsin.

Dr. Pray is a member of the American Chemical Society, The Electrochemical Society, The American Electroplaters' Society, Phi Lambda Upsilon, honorary chemical society, and Sigma Xi, national honorary science society.

Nathan E. Promisel has become Process Engineer and Metallurgist of the Navy Department, Bureau of Aeronautics, Washington, D. C. He recently was a consultant in the electroplating and chemical fields, and before engaging in consulting work was in the research laboratories of the International Silver Co., Meriden, Conn. Mr. Promisel, who is a graduate of Massachusetts Institute of Technology, has presented numerous papers to the American Electroplaters' Society, the Electrochemical Society, and is a regular contributor to *Metal Finishing*.

Anthony J. Chenis has recently joined the Bullard-Dunn Process Division of The Bullard Company, Bridgeport, Conn., having charge of the Bullard-Dunn Process laboratory.

Mr. Chenis' background for this position comprises the following: He graduated from Holy Cross in 1935 in the chemistry course. From 1935-1937 he was associated with Boston College with a Teaching Fellowship, and while there received an M.S. degree. In the years 1937 and 1938 he attended Massachusetts Institute of Technology studying metallurgy.

From there he became associated with Blacher Brothers where he was in charge of finishing and plating, and is now connected with the Bullard-Dunn Process Division of The Bullard Company.

## Business Items

### Hanson-Van Winkle-Munning Co. Expands

The Hanson-Van Winkle-Munning Company of Matawan, N. J., manufacturers of electroplating equipment and supplies, are moving ahead at full speed to expand and improve their plant and facilities. They now have in process a complete overhaul and a considerable increase in their laboratory which will include new offices, a library and a conference room. Plant revisions are practically finished including increased space for the expanded engineering department and a new vault for drawings. They

are making additions to their foundry and adding two short bays to the electrical department and machine shop. The latest improvement is a complete renovation of their Bridgeport factory.

An interesting feature is the installation of 18 foot fluorescent lighting units in the new engineering department addition. These are believed to be among the largest industrial units built.

### Organization Changes Announced by Tolhurst

Wayne Mendell, general sales manager, American Machine and Metals, Inc., East Moline, Illinois, has announced important changes in personnel of the Tolhurst Centrifugal Division.

Howard H. Harlan, sales engineer and recently manager of the New York office of

Tolhurst, has been appointed Technical Assistant to the General Sales Manager, with offices in Washington, D. C., where he will maintain contact with federal government offices. Mr. Harlan will also visit the factory at East Moline periodically as technical advisor to the sales department.

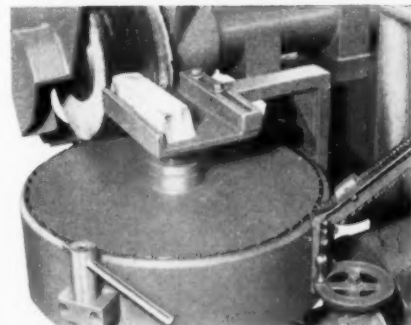
George P. Hebard, formerly advertising manager, U. S. Hoffman Machinery Corporation, district manager for Fletcher Works, Inc., and recently sales and advertising manager of G. H. Bishop Company, has been made field sales promotion manager.

Branch office changes include the appointment of J. R. Angel as manager of the New York office and W. C. Davis in charge of the Atlanta office. Mr. Angel was formerly manager of the Atlanta territory for Tolhurst, while Mr. Davis represented the company in Maryland, Virginia and District

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*Polished or Buffed*  
at the rate of  
**5,000 to 10,000 per Hour!**



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Acme Type "SM"

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This is, of course, but one of the many types of Acme polishing and buffing machines in widespread use for speeding up production and reducing operating costs. If you have a buffing or polishing problem, the chances are there is an Acme machine that will solve it.

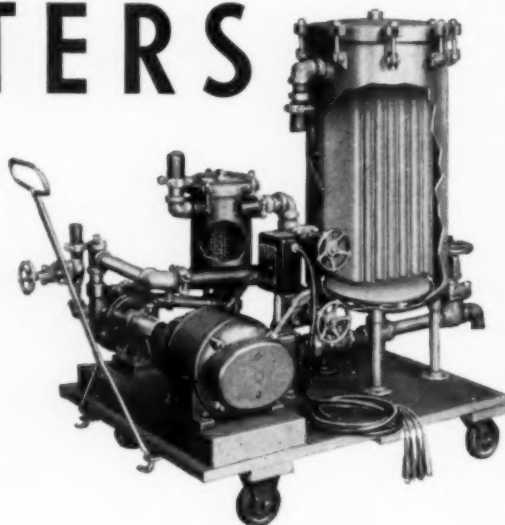
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*Builders* OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

# FILTERS

For

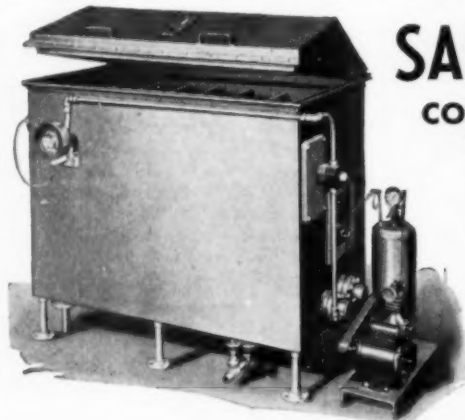
Bright Nickel  
Nickel  
Chrome  
Copper Sulphate  
Cyanide Copper  
Brass and Zinc  
Cadmium  
High Speed Copper  
Bright Zinc  
Silver  
Electrocolor  
And Others



INDUSTRIAL FILTERS will do a fine job of filtering and purifying your plating solutions, at the lowest possible cost per filtered gallon.

INDUSTRIAL FILTERS have larger filter areas, more sludge holding capacity and higher pressure pumps, which insures high flow rates and longer filter cycles.

The "LEAK-PROOF", "CORROSION-PROOF" and non-contaminating construction of Industrial Filters is a vital requisite of Electroplating filters.



## SALT SPRAY CORROSION TEST EQUIPMENT

For testing—Electroplated or coated metals at 95 deg. Fah. in accordance with Army, Navy and Aeronautical specifications, as outlined in Bulletin AN-QQ-S-91-5 dated Dec. 1938. Also for controlled temperatures at any degree. Testing Cabinets lined throughout with rubber. Made in 4 sizes.

"Write for NEW Literature and particulars."

**INDUSTRIAL FILTER & PUMP MFG. CO.**  
3017 WEST CARROLL AVENUE CHICAGO, ILLINOIS

of Columbia. Prior to joining Tolhurst, Mr. Davis was associated with Du Pont and the General Chemical Company.

Another acquisition to the company's personnel, announced by Mr. Mendell, is the appointment of *Albert L. Ewing* as chief clerk in the general sales department. Mr. Ewing was formerly associated with the Fletcher Works, Inc., as accountant. His headquarters will be in East Moline.

*American K.A.T. Corp.*, have announced the opening of a Philadelphia office under the supervision of *Frank Campbell Coe* at the Commercial Trust Bldg., Fifteenth and Market Sts., to sell and serve the users of the company's colloidal water treatment.

*National Aircraft Equipment Co.* has completed installation of a large plating and polishing plant in its Los Angeles factory at 1819 Barranca St.

Plating and auxiliary equipment installed includes a 100 gallon chrome and a 300 gallon nickel tank, four polishing lathes, four hard-wheel grinders, four disc grinders.

The company manufactures aluminum drop forgings for aircraft plants. Operations include polishing, plating, buffing and grinding. *W. A. Shuler*, formerly superintendent of the plating shop for Namac Products, is superintendent of the bucking bar division at National Aircraft. His son, *W. R. Shuler*, has succeeded him as foreman at the Namac plant.

### Foxboro Company Erects Own Pittsburgh Building

Responding to the greatly increased needs of industrial companies in the Pittsburgh territory, *The Foxboro Company*, makers of instruments for measurement and control, is erecting its own building at 5151 Baum Blvd., where servicing department and offices will be located after May 15. The building is entirely of masonry and steel and conforms to the best principles of modern design. It is completely air-conditioned and is equipped with fluorescent lighting. Bays of glass blocks take the place of windows.

*If you, as a metal fabricator, have difficult cleaning problems the Magnuson Research Service will help solve them.*

—MAGNUSON'S monthly message

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Cleaning Compounds

Cleaning metals is a vital part of many production programs, especially in work relating to the National Defense Plan. Industries doing electroplating, galvanizing, lacquering, painting, or rust-proofing require an absolutely dependable cleaner for securing clean surfaces. PERMAG is the Cleaner used. It is efficient, acts rapidly, low in cost and absolutely GUARANTEED.

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Manufacturers of Specialized Scientific Cleaning Compounds for every Industrial Purpose  
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Assembly and servicing departments will occupy the entire first floor area of about 3700 square feet, and 1250 square feet of additional space will be used for offices, on the second floor. A giant thermometer with 4-foot dial, set in the front wall of the building, will indicate outdoor temperature and will also serve to identify the nature of the company's business.

The territory served by the Pittsburgh branch includes the great industrial section embracing parts of Pennsylvania, West Virginia, Ohio, and Kentucky. The Foxboro Company has always been a large supplier of instruments for the metals industries, as well as the gas, petroleum, ceramic and glass industries, and the extended facilities which the new Pittsburgh building will afford in this busy territory come most opportunely at this time. A. H. Shafer continues as manager of the Pittsburgh branch. The home office of The Foxboro Company is at Foxboro, Mass.

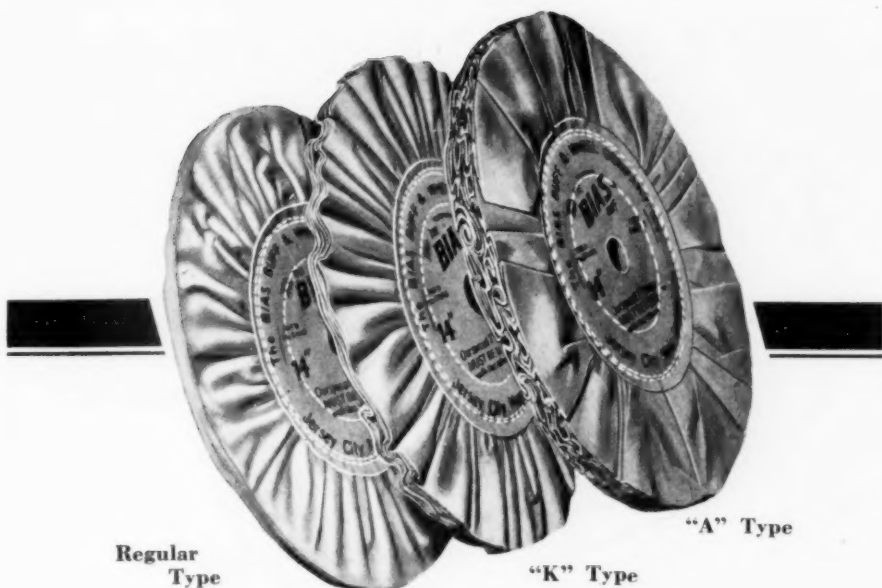
#### Pennsylvania Salt Representatives Meet

William P. Drake, manager of the Pennsylvania Salt Cleaner Division of the Pennsylvania Salt Manufacturing Company, called a meeting of his technical sales force at the Penn Athletic Club in Philadelphia, on Friday, March 28, and Saturday, March 29, for the purpose of considering new service and marketing problems presented by the National Defense Emergency. In attendance were the following technical men who aid the company's regular sales representatives in its district offices throughout the United States: Albert H. Clem, John S. Dimon, Joseph J. Duffy, Jr., William J. Hennessy, Joseph W. Manz, Willis J. Stoddard, William M. Swain, Clarence W. Burkhart, and Walter S. Riggs, Manager of Development of the Research & Development Department.

George B. Beitzel, Manager of Sales, gave a short talk on the importance of this group in relation to the company's sales and merchandising program. Richard L. Davies, Manager of Market Research, explained to the group the part it is expected to play in the company's future activities in the



William P. Drake



## Buffing Costs Reduced—Profits Increased by using better buffs—BIAS Buffs

The right buff for the job has always been a fixed principle in BIAS Buff manufacturing and selling. We make the buff that does the job better—a buff that works without waste. Cloth in a BIAS BUFF never ravel, it's bias cut and formed. Three representative buffs are shown above. "A" Type is for color work, but also for general use. "K" is for hard tough cutting down; the "REGULAR" is for general work. These BIAS Buffs have records, because they do a thorough job on a cost saving basis. Try them.

**The BIAS BUFF and WHEEL CO., Inc.**  
430 Communipaw Ave. Jersey City, N. J.

metal cleaning and related markets. H. M. Ellsworth led a discussion on the service the technical sales force can render in connection with the advertising of the company's cleaners.

Saturday was devoted to demonstrations and discussions in the new development and service laboratory where the men were given a preview of new products which the Research & Development Department has perfected. It is expected that these new products will soon be released.

Sharples Solvents Corp., Philadelphia, Pa., on April 28 changed its corporate name to Sharples Chemicals, Inc. This change in corporate name proved necessary because of the production and development of many new organic chemicals which has made it desirable for the company to be identified as a chemical company rather than as a solvents manufacturer. The company will also continue to manufacture those products for which it has long been known.

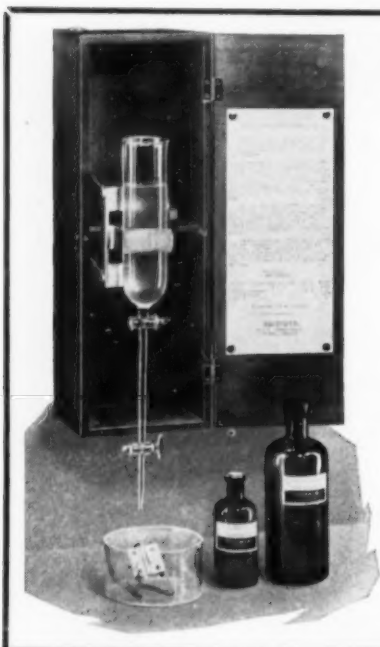
## Patent Digest

(Concluded from page 259)

### Corrosion Prevention of Copper & Alloys

U. S. Patent No. 2,233,422. H. J. Lodgesen, Mar. 4, 1941. A process for retarding corrosion of copper and its alloys which comprises subjecting to the action of a solution containing an acid phosphate of the group containing zinc, manganese, cadmium and magnesium and an oxidizing agent selected from the group consisting of chlorates, bromates, periodates, hypochlorites and quinone and thereafter subjecting to a final rinse in a solution containing an acid selected from the group consisting of chromic, phosphoric or oxalic acids.

Example: For brass. To 100 gal. of water add 26 lbs. of magnesium dihydrogen phosphate and 4.5 lbs. of sodium bromate. Immerse article at 210° F. for approximately 5 minutes or spray the solution on. The final



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## New Improved LUSTREBRIGHT BRIGHT NICKEL PROCESS

PRODUCES BRILLIANT, LUSTROUS NICKEL DEPOSITS.  
ELIMINATES COLOR BUFFING—RE-CLEANING—RE-RACKING.  
AN IDEAL BASE FOR CHROMIUM. EXCELLENT THROWING POWER.  
NO SPECIAL SOLUTIONS OR CHANGES IN EQUIPMENT REQUIRED.  
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Uniform results obtained on all classes of work in still tanks or mechanical barrels. Excellent for zinc die-castings. Any cold nickel solution of standard formula will with the addition of NEW IMPROVED LUSTREBRIGHT give brilliant, lustrous, adherent deposits. Guaranteed not to harm plating solution or cause plate to peel, become brittle or produce streaky deposits. Illustration shows unbuffed deposits produced before and after addition of NEW IMPROVED LUSTREBRIGHT. Write for complete information.

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**Greensburg, Pa.**

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rinse may contain 7-21 oz. of chromic acid, phosphoric acid, oxalic acid in 100 gallons, or various metal salts, at a temperature of 150-180° F. for 1 minute.

*Example:* For copper. To 100 gal. of water add 25.2 lbs. of zinc dihydrogen phosphate and 9 lbs. of sodium chlorate. Boil. The increase of the zinc content by adding 9 lbs. of a soluble zinc salt improves the coating. The solution should test 2.2 free acid and 15.5 total acid. The operating conditions are the same as for brass.

### Electroformed Screen

U. S. Patent 2,231,678 E. O. Norris, assignor to Edward O. Norris, Inc., February 11, 1941. A method of making a matrix comprising the steps of forming a plate of metal with a plurality of projections on one face thereof, coating the surface of the plate of metal around the base of the projections with a non-conductive material, electrodepositing metal on the surface of the projections to an extent to overlie the non-conducting material, removing the non-conductive material and then depositing a layer of metal on the surface of the plate having the projections thereon, and then dissolving the plate of metal.

### Strip and Wire Treating Machine

U. S. Patent 2,232,019 G. J. Beckwith, assignor to The American Steel and Wire Co. of New Jersey, February 18, 1941. An apparatus for electrolytically treating metal strip and wire.

### Corrosion Prevention

U. S. Patent 2,227,469 J. S. Thompson and E. W. Goodspeed, January 7, 1941. A method of rendering metals including iron, steel, zinc, galvanized metal, aluminum, stainless steel, rustless iron, lead, tin, terne plate, cadmium, nickel, copper and magnesium resistant to corrosion by subjecting the surfaces to the action of vaporized chromic acid in combination with either ferric chloride, sodium chloride or hydrochloric acid to lower the vaporization point at a temperature between 450°-1,000° F., preferably followed by a water rinse and finally by a rinse in a solution of chromic acid (4 gms./gal. for example) at room temperature to boiling. Any salt of chromic acid may be used in combination with a mineral acid.

### Cleaning Aluminum and Alloys

U. S. Patent 2,228,026 J. P. Abrahams, assignor to Koninklijke Zwavelzuurfabrieken voorheen Ketjen N. V. (Netherlands), January 7, 1941. A process of removing the black scale consisting chiefly of hard carbon and decomposed and dried oil from aluminum alloy engine parts by immersing in oleum containing 30% free SO<sub>2</sub> for 10 hours with agitation, followed by a rinse in 60° sulfuric acid and then in 5% ammonia in which the smut is brushed off. The article is then rinsed and dried. If sulfuric acid of less than 100% strength is used, heating of the solution is recommended. The process is satisfactory when the aluminum assemblies contain iron sections if the sulfuric acid is more than 50° Be.

# Supply Prices, April 28, 1941

## Anodes

Prices are f.o.b. shipping point on quantities of from 500-999 lbs. for copper, brass and zinc. For nickel, prices are for quantities from 500-2,999 lbs.					
COPPER:	Cast, elliptical, 15" and longer	.25¼c. per lb.	ZINC: Cast, 99.99, 16" and over	15¼c. per lb.	
	Electrolytic, full size, .22¾c; cut to size	.22¾c. per lb.	NICKEL: 95-97 cast, elliptical 46c. per lb., 99% plus		
	Rolled, oval, straight 15" and longer		cast 47c.; Rolled, depolarized	48c. per lb.	
	.23¼c. per lb.; curved	.24¼c. per lb.	SILVER: Rolled, .999 fine per Troy oz.	38c. per oz.	
BRASS:	Cast, 80-20, elliptical, 15" and longer	.23¾c. per lb.			

## Chemicals

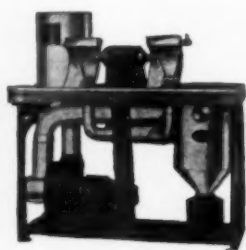
These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P., drums, l.c.l.	lb.	.08	Hydrogen Peroxide, 100 volume, carboys	lb.	.16-18 $\frac{1}{2}$
Acid, Boric tech., 99.5% gran., bbls.	lb.	.0615	Iron Sulphate (Copperas), cryst., bbls., 1-4 wks.	lb.	.02
Chromic, 99%, 100 lb. and 400 lb. drums, l.c.l.	lb.	.17 $\frac{1}{4}$	Lead, Acetate (Sugar of Lead), crystals, bbls.	lb.	.11
Hydrochloric (muriatic) Tech., 20°, carboys, wks.	lb.	.0245	Oxide (Litharge), com., powdered, bbls.	lb.	.08 $\frac{1}{4}$
Hydrochloric, C.P., 20°, bottles	lb.	.19	Magnesium Sulphate (Epsom Salts), tech., bbls.	lb.	.018
Hydrofluoric, 30% bbls.	lb.	.06-.06 $\frac{1}{2}$	Mercury Bichloride (Corrosive Sublimate), crys.	lb.	\$2.19
Nitric, 36°, carboys 1-9, wks.	lb.	.0595	Mercuric Oxide, tech., red, powder, bbls.	lb.	\$2.81
Nitric, 42°, carboys 1-9, wks.	lb.	.0745	Nickel, Carbonate, dry, bbls.	lb.	.36-.36 $\frac{1}{2}$
Oleic (Red Oil), distilled, drums	lb.	.10 $\frac{1}{2}$ -.11 $\frac{1}{2}$	Chloride, bbls.	lb.	.18-.20
Oxalic, bbls. l.c.l.	lb.	.14	Salts, single, 425 lb. bbls.	lb.	.135-.145
Stearic, distilled, double pressed, bags	lb.	.12 $\frac{3}{4}$ -.13 $\frac{3}{4}$	Salts, double, 425 lb. bbls.	lb.	.135-.145
single pressed, bags	lb.	.12 $\frac{3}{4}$ -.13 $\frac{3}{4}$	Paraffin, refined, bgs., 123-125 a.m.p., c.l.	lb.	.057
triple pressed, bags	lb.	.15 $\frac{1}{2}$ -.16 $\frac{1}{2}$	Perchlorethylene, drums, l.c.l.	lb.	.08 $\frac{1}{2}$
Sulphuric, 66°, carboys 1-9, wks.	lb.	.0220	Phosphorus, red, cases	lb.	.44
Alcohol, Amyl, (Fusel oil, ref'd), l.c.l., drums	lb.	.16-17 $\frac{1}{2}$	yellow, cases	lb.	.23-.25
Butyl-normal, l.c.l., drums	lb.	.105	Potash, Caustic, 88-92%, flake, drums, works, c.l.	lb.	.07
Denat., S.D. #1, 190 pf., 1-18 drms, wks.	gal.	.35	Potassium Bichromate, crystals, casks	lb.	.09 $\frac{1}{4}$
Diacetone, tech., drums, l.c.l.	lb.	.09 $\frac{1}{2}$ -.10 $\frac{1}{2}$	Carbonate (potash) calc., wks, drums	lb.	.06 $\frac{1}{4}$
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.38	Cyanide, 94-96%, dom. dms, wks.	lb.	.55
Propyl-Iso, 99%, drums, l.c.l.	gal.	.43-.47	Pumice, ground, 1 $\frac{1}{2}$ F. & coarser, bbls., wks.	lb.	No price
Propyl-Normal, drums, wks.	gal.	.70	Quicksilver (Mercury), dom. 76 lb. flasks, net	flask	\$183.
Alum, ammonia, granular, bbls., works	lb.	.035	Rochelle Salts, crystals, bbls.	lb.	.40
Potash, granular, bbls., works	lb.	.0375	Rosin, gum, B, bbls., dock	lb.	.0207
Ammonia, aqua, 26°, carboys	lb.	.05 $\frac{1}{4}$	Silver, Chloride, dry, 50 oz. lots	oz.	.37 $\frac{1}{2}$
Ammonium, chloride (sal-ammoniac), white, granu-	lb.	.0445	Cyanide, 100 oz. lots	oz.	.33 $\frac{1}{4}$
lar, bbls., wks.	lb.	.65	Nitrate, 100 oz. lots	oz.	.24
Sulphocyanide (thiocyanate), pure, crystal, kegs.	lb.	.40	Sodium, Carb. (soda ash), light, 58%, bags	lb.	.0208
Sulphocyanide (thiocyanate), tech., kegs	lb.	.40	Cyanide, 96%, dom. 100 lb. drums	lb.	.15
Antimony Chloride (butter of antimony), sol.,	lb.	.17	Hydroxide (caustic soda) 76%, flake, l.c.l.	lb.	.0490
carboys	lb.	.17	Hyposulphite, crystals, bags, wks.	lb.	.0250
Barium Carbonate, ppted., bags, l.c.l., works	lb.	.025	Metasilicate, granular, 1-9 bbls.	lb.	.0335
Benzene (Benzol), 90%, drums, works	gal.	.19	Nitrate, rfd., gran., bbls., wks.	lb.	.029
Butyl Lactate, drums	lb.	.235	Phosphate, tribasic, tech., bbls., wks.	lb.	.0295
Cadmium Oxide, l.c.l., bbls.	lb.	.95	Pyrophosphate, anhydrous, bags, l.c.l.	lb.	.0560
Calcium Carbonate (Ppted. chalk), c.l., wks.	lb.	.02 $\frac{1}{4}$	Sesquisilicate, 1-9 drums	lb.	.0425
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05 $\frac{1}{4}$	Stannate, drums	lb.	.365
Carbon Tetrachloride, l.c.l., drums	gal.	.73	Sulphate, anhydrous, bbls., works	lb.	.0215
Chromic Sulphate, scale, 100 lb. drums	lb.	.45	Sulphocyanide, drums	lb.	.28-.47
Cobalt Sulphate, drums	lb.	.71	Sulphur, Flowers, U.S.P., bbls., l.c.l. mine	lb.	.0335
Copper, Acetate (verdigris), bbls.	lb.	.22-.23	Tin Chloride, crystals, kgs.	lb.	.39 $\frac{1}{2}$
Carbonate, 52-54%, bbls.	lb.	.16 $\frac{1}{2}$	Toluene (Toluol), 2°, ind., drums, works	gal.	.32
Cyanide, Tech., 100 lb. bbls.	lb.	.34	Trichlorethylene, drums, l.c.l., zone 1	lb.	.08 $\frac{1}{2}$
Sulphate, 99%, crystals, bbls., 1-5	lb.	.0535	Tripoli, air floated, bgs., c.l., wks.	ton	\$26.00
Cream of Tartar (potassium bitartrate), gran., kegs	lb.	.53 $\frac{1}{2}$	Wax, Bees, white, bleached, slabs, 1-5 cases	lb.	.38-.40
Crocus Martis (iron oxide) red, bbls.	lb.	.03	Bees, yellow, crude, Brazil, 100 lbs.	lb.	.32 $\frac{1}{2}$
Dibutyl Phthalate, drums, l.c.l.	lb.	.195	Carnauba, refined, bags	lb.	.65-.66
Diethylene Glycol, drums, l.c.l., works	lb.	.155	Montan, bags	lb.	No prices
Dextrin, white, bags, F.O.B. Chicago	lb.	.0385	Spermaceti, blocks	lb.	.24-.25
Emery (Turkish)	lb.	.08	Whiting, precipitated, bags, l.c.l.	ton	\$20.00
Ethyl Acetate, 85%, l.c.l., drums, works	lb.	.075	Xylene (Xylol), ind., returnable drums, works	gal.	.31
Ethylene Glycol, l.c.l., drums, works	lb.	.15 $\frac{1}{2}$ -.18 $\frac{1}{2}$	Zinc, carbonate, tech., bbls.	lb.	.14-.16
Monoethyl ether, dms., l.c.l., wks.	lb.	.145	Cyanide, 100 lb. kegs	lb.	.33
Gold, Chloride, yellow, bottles	oz.	\$19.25	Chloride, tech., granular, drums, c.l., wks.	lb.	.05
Cyanide, potassium 41%, bottles, wks.	oz.	\$14.20-\$15.45	Sulphate, crystals, bbls., l.c.l.	lb.	.039
Gum, Arabic, white, powder, bbls.	lb.	.19-.21			





Blower



Polishing Bench



Dryer



Tubbing



Sawdust Box

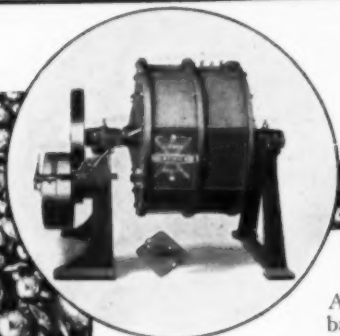


Sandblast

## THE BOLAND SYSTEMS

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